A PARAMETRIC BUILDING ENERGY COST OPTIMIZATION TOOL BASED ON A GENETIC ALGORITHM

A Record of Study

by

XIAOWEI TAN

Submitted to the Office of Graduate Studies of
Texas A&M University
in partial fulfillment of the requirements
for the degree of

DOCTOR OF ENGINEERING

May 2006

Major Subject: Engineering
College of Engineering

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ABSTRACT

A Parametric Building Energy Cost Optimization Tool Based on a Genetic Algorithm.

(May 2006)

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This record of study summarizes the work accomplished during the internship at the Energy Systems Laboratory of the Texas Engineering Experiment Station. The internship project was to develop a tool to optimize the building parameters so that the overall building energy cost is minimized. A metaheuristic: genetic algorithm was identified as the solution algorithm and was implemented in the problem under study.

Through two case studies, the impacts of the three genetic algorithm parameters, namely population size, crossover and mutation rates, on the algorithm's overall performance are also studied through statistical tests. Through these statistical tests, the optimum combination of above the mentioned parameters is also identified and applied.

Finally, a performance analysis based on the case studies show that the tool achieved satisfactory results.

DEDICATION

This record of study is dedicated to my parents, for their kindly love and support.

ACKNOWLEDGEMENTS

I would like to take this opportunity to thank Dr. Phillips and all the committee for the support and guidance I have received. Here, I also want to give special thanks to Dr. Culp, my internship supervisor, for his unselfish mentorship, which goes far beyond the realm of academics.

I also need to give credit to Mr. Adarsh Joshi of the Department of Statistics, for this help at the statistics help desk in helping me select appropriate statistical test methods.

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I. INTRODUCTION

This record of study is in partial fulfillment of the requirements of the Doctor of Engineering degree. It also serves as a report on the internship conducted at the Energy Systems Laboratory, located in the Wisenbaker Engineering Research Center, Texas A&M University, College Station, Texas.

This record of study follows the style and the format of *IIE Transactions*.

II. INTERNSHIP BACKGROUND

II.1. Energy Systems Laboratory Background

Energy Systems Laboratory is a division of the Texas Engineering Experiment Station. It was first established in 1939 as Fan Testing Laboratory for the Home Ventilating Institute. Over the years of development, the lab gradually included more research capabilities on air conditioners, heat pumps, buildings, flow meters, noise and fires, and building energy analysis. It finally renamed to its current name in 1985. Currently Energy Systems Laboratory specializes in research in three major areas: (1) Metering and modeling building energy usage; (2) Optimization of heating, ventilation and cooling systems; (3) Modeling and analysis using data collected, including calibrated simulation models, and measurement and verification of photovoltaic solar installations.

Major projects going on at Energy Systems Laboratory include: (1) Texas Senate Bill 5 Code training and emission analysis program (SB5 program); (2) Equipment Testing Services; (3) Continuous Commissioning Program; and (4) eCalc energy and emission reductions calculator (eCalc) program. (5) Measured and verification technology development.

SB5 program is based on State of Texas legislature: the Texas Emissions Reduction Plan (TERP). The lab's role includes: (1) Reporting energy savings to the Texas Public Utility Commission and the Texas Natural Resources Conservation Commission for the purpose of assisting Texas to obtain emissions reduction credits in the State Implementation Plan (SIP) with the United States Environmental Protection Agency

(EPA); (2) Assisting and training customers on implementing, evaluating and quantifying energy efficiency standards of codes. Equipment Testing Service program mainly provides testing certifications heating, ventilating and air conditioning systems; Continuous Commissioning program strives to optimize building heating, ventilation and air conditioning (HVAC) system operation and control by retrofitting the system with more energy efficient equipment and providing better monitoring and operating practice. eCalc program is to develop a Web-based energy and emissions calculator designed to calculate different energy systems energy consumption and emission levels. The energy systems include: new buildings, community and renewable energy systems.

II.2. eCalc Project

It's necessary to go into details of eCalc project because the whole internship project is closely tied to the eCalc project. The full name of eCalc is Texas Energy Emissions and Efficiency Calculator; it's a web based energy calculator accessible to the general public. Functionally, it is capable of accurately estimating energy and emissions (NOx, SOx, and CO2) reductions from three different sources: (1)adoption of Texas state wide energy efficiency standards for new individual residential, new multifamily and new commercial buildings projects, and those building projects include: single family house, multifamily apartments, municipal buildings, and office buildings; (2) Renewable energy systems projects, which contains: solar thermo systems, solar photovoltaic systems, and wind turbine generator systems; (3) Community-based energy efficiency projects which includes street lights, traffic lights, water supply and waste water projects. The eCalc structure chart is summarized in Fig. 1.

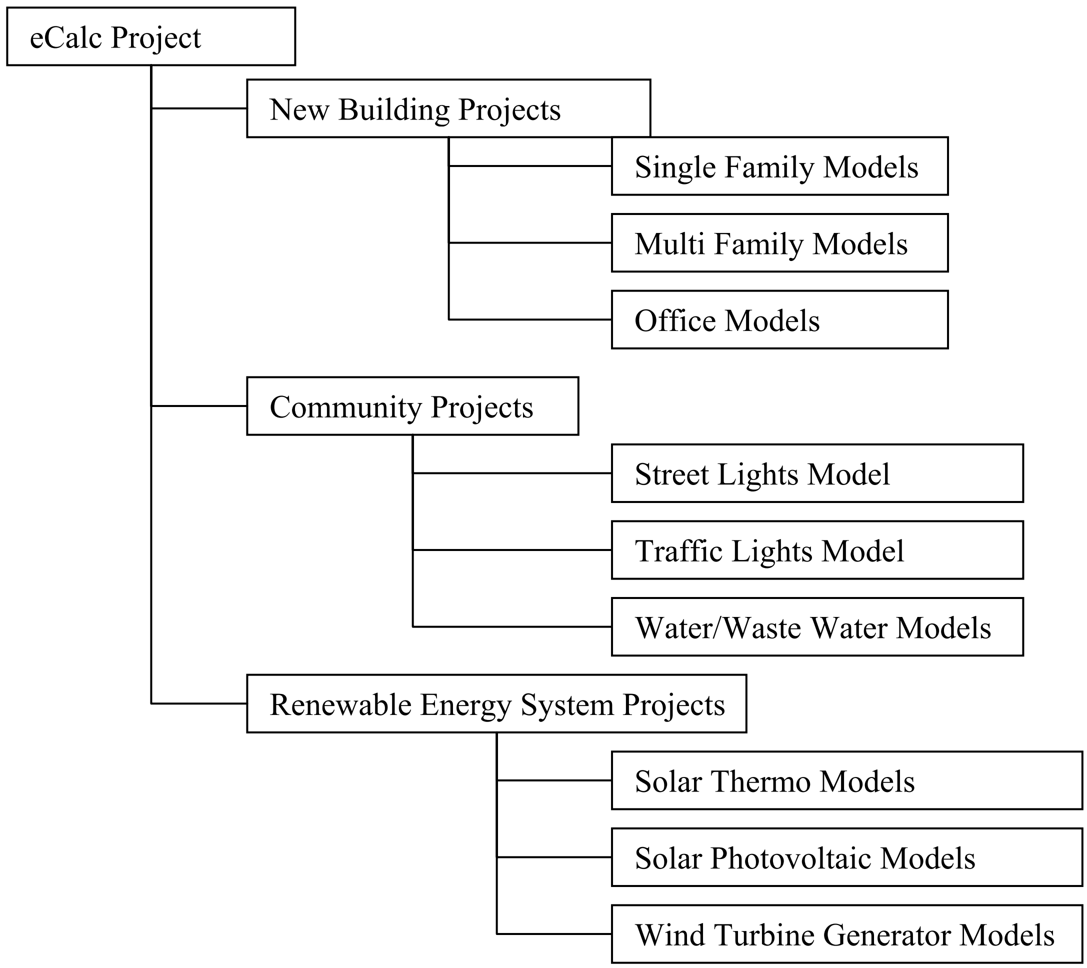

Fig. 1. eCalc project organizational chart

III. THE INTERNSHIP PROJECT

III.1. Project Origin

The initial thought of the internship project was originated from the eCalc project at Energy Systems Laboratory. eCalc project's fundamental role is to estimate an energy system's energy consumption based on the system's information as input factors.

Those input factors differ across different energy systems: For simpler models such as solar thermo or solar photovoltaic models, factors include geographical information (longitude, latitude), collector surface, angle, orientation, etc. Input factors are more complicated for models in new building projects. For example, input factors for single family models include: building size, orientation, cooling/heating system configurations, window-to-wall area ratio, etc. For new building projects, those input factors can be classified into three categories: (1) interior load; (2) exterior load; (3) building heat loss.

Interior load is caused by (1) the activities of a building's occupants, such as human, lightings and equipment; (2) Heating, Ventilating and Air Conditioning (HVAC) systems and domestic hot water systems. Exterior load comes from (1) solar radiation, (2) climate conditions, such as temperature, humidity, and wind conditions. Building heat loss has more to do with building envelop (this term will be explained in detail later in the section) data, which includes building size, window configuration, construction material, etc.

Put into a functional form, an energy system's energy consumption prediction can be expressed as a function of all these above mentioned input factors. Here an interesting question is: if a designer is allowed to modify these input factors, is there a way to find out a design such that the overall energy system's energy cost is minimized?

A first glance of the problem might lead to the decision to adopt more energy efficient equipments, or better insulation materials, etc. However, a second thought reveals that the problem is more complicated than it appears.

Take new building models as an example: On the one hand, better building materials or more energy efficient equipments may help the building to reduce energy consumption; however in most cases those materials and equipment often come with extra cost: double pane windows always costs more than their single pane counterpart, higher efficiency air conditioning systems is more expensive than air conditioning systems with lower efficiency. On the other hand, the interactions among different input factors also make the problem more complicated. For example, window size behaves in different ways on building energy cost under different climates conditions. Bigger windows size allows more solar heat penetration. In cold climate this helps to reduce energy cost on heating but in warmer climates it's usually not recommended as more cooling power is needed to neutralize the extra solar radiation passed through the window. Another example, normally building orientation doesn't have a big impact on building energy consumption, but under some circumstances, such as uneven window-to-wall ratio on different sides of the building, different orientation will result in big fluctuation in energy consumption.

The current research efforts at Energy Systems Laboratory on solving energy efficiency problem are predominantly on single factor analysis, and the results only have limited practical applications. Developing a building energy cost optimization tool that can handle multiple, comprehensive input factors will add more strength in Energy Systems Laboratory's research in energy conservation technologies. Internship Project Scope

The primary objective of the project is to develop a parametric energy cost optimization tool for eCalc models, and the name of the tool will be referred to as eCalc-Op. This section will delineate the detailed project scope based on this objective

The scope of the internship project covers three areas: (1) Applicable models which define which of the eCalc projects eCalc-Op is applied to; (2) Input parameters to be optimized; and (3) Implementation and performance analysis.

III.2. Applicable Models

All of the three eCalc project types, namely new building projects, community projects, and renewable energy projects are candidates for eCalc-Op. Out of these three project types, new building projects are the most complex in terms of the number of input factors. Each of the three building models (single family, multifamily, office building) has at least 50 input parameters; while in comparison, the number of input parameters of other eCalc project models ranges from only 10 to 15. In the light of the fact that not all input parameters can be selected as subject parameters for eCalc-Op optimization, the sheer number of input parameters that new building projects models have offers an excellent pool of candidate parameters than any other eCalc projects. Thus, models in new building projects are more representative to the eCalc-Op's need --- if new building projects are applicable, then eCalc-Op can be applied to any eCalc projects.

As a result, eCalc-Op will adopt models in new building project as subject for energy optimization.

III.3. Input Factors to Be Optimized

Input factors to be optimized are called decision variables in operations research. For the purpose of consistency, input factors will be referred to as decision variables.

Because eCalc-Op is based on eCalc, decision variables are picked from eCalc input parameters (For a detailed list of those parameters, please refer to eCalc project single family, multifamily and office model spec sheets). As mentioned previously there are three factors affecting a building's energy consumption: exterior load, interior load and building heat loss. As a result, eCalc's input parameters are also categorized into three categories: exterior load parameters, interior load parameters, and building envelop. Exterior and interior load are self-explanatory, and those parameters include: building location such as longitude and latitude, number of occupants, HVAC system configuration and settings, etc. Building heat loss is associated with building envelop design. Watt (1999) defines building envelop as "buffers or filters external conditions for internal needs". Building envelop includes all the building components that separate the indoor from its outside environment. Some examples of building envelop include: building length, width, depth, wall and roof insulation, window-to-wall ratio, etc.

One thing to notice when determining those input factors (decision variables) is: not all the eCalc input parameters in these three categories will be included as candidates for decision variables. There are two reasons: (1)Some parameters are not "optimizable".

For example, some of the building exterior load factors, such as a building's geographical location (longitude and latitude, elevation) information. They determine the building's exterior thermo load property and therefore have a big impact on building's energy cost; unfortunately such parameters should not be included as decision variables since building's location is not supposed to be altered just for energy efficiency purpose. As a result, factors whose values are not supposed to be changeable are dropped. (2) The other reason is some parameters only have a limited impact on overall system energy cost, such as floor weight and window frame type. Therefore, those parameters are also excluded.

Because of the difference between residential buildings and office buildings, eCalc's single family and multifamily models are combined as residential building models. As a result eCalc-Op's decision variables are also classified into residential buildings decision variables and office buildings decision variables. With the help from Mr. Mushtaq Ahmad of Energy Systems Laboratory, following building parameters in Table 1 are identified as decision variables. It can be seen from the table that because of above mentioned reasons, most of the exterior and some of the interior load factors are dropped and the list contains mostly of envelop load factors.

III.4. Implementation and Performance Analysis

After the solution algorithm to the internship project is identified, it will be implemented in computer program. As part of the software engineering practice, the computer programming implementation must be documented and therefore included in this record of study. One important property of any optimization algorithms is the algorithm's efficiency, which measures how fast the algorithm can find optimum solution. After the program prototype is done, the solution algorithm will also be evaluated.

Table 1. List of decision variables for eCalc building models

Residential Buildings	Office Buildings
Envelope	Envelope
Building Width	Building Width
Building Depth	Building Depth
Building Height	Building Height
Azimuth	Azimuth
Crawl Space Thickness Above Ground	
Crawl Space Thickness under Ground	
Wall Insulation	Wall Insulation
Roof Insulation	Roof Insulation
Window to Wall Ratio	Window to Wall Ratio
U-Factor Glazing	U-Factor Glazing
Solar Heat Gain Coefficient (SHGC)	Solar Heat Gain Coefficient (SHGC)
Shades	Shades
Interior Load	Interior Load
Cooling System Efficiency	Cooling System Efficiency
Annual Fuel Utilization Efficiency (AFUE)	Annual Fuel Utilization Efficiency (AFUE)
Heating Seasonal Performance Factor (HSPF)	Heating Seasonal Performance Factor (HSPF)
Air Exchange	Fan Control
Domestic Hot Water Heater Efficiency	Domestic Hot Water Heater Efficiency
	Outside Air Fraction Control
	Supply Air Pressure
	Chiller Efficiency
	Boiler Efficiency

IV. PROBLEM AND SOLUTION

IV.1. Project Problem Definition

The problem proposed can be defined as: minimize a building's cost energy related cost by varying values of a given set of input factors which each has its own constraints. Specifically, the optimization problem is formulated as:

$$\min : z = c(\vec{x}) + m(\vec{x}) \tag{1}$$

Subject to:

$$\vec{L} \le \vec{x} \le \vec{U} \tag{2}$$

$$g(\vec{x}) \le \vec{b} \tag{3}$$

$$\vec{x} \in E^n$$

where:

$\vec{x}$: vector of decision variables to be minimized;

$c(\vec{x})$: direct energy consumption cost;

$m(\vec{x})$: indirect energy related costs, such as installation, maintenance, etc.;

$\vec{L}$, $\vec{U}$: Lower bound and upper bound for $\vec{x}$, respectively;

$g(\vec{x}) \le \vec{b}$: other miscellaneous constraints

IV.1.1 Decision Variable

A list of decision variables are identified in previous section where they are addressed briefly. Table 17 and Table 18 of APPENDIX A give a more detailed list and explanation of those decision variables. Table 17 contains the list of decision variables for residential building models, while those of office building models are contained in Table 18. Decision variables' name, description and lower and upper bound are given in both tables. Here please note that when it comes to the implementation of those decision variables, the upper bound and lower bound for each decision variable are restricted by the upper bounds and lower bounds set in the table. For example, building width for residential buildings in Table 17 has a lower bound and upper bound of 30 feet and 200 feet respectively. This means for any implementation of the decision variable, lower bound of building width cannot be less than 30 feet and upper bound cannot exceed 200 feet.

IV.1.2 Objective Function

Objective function evaluates the annual electricity cost in dollar amount based on the given decision variables. Because eCalc-Op is a general purpose optimization tool, eCalc-Op's objective function doesn't have a specific formulation. Here, only a general form is given, as in (1). It has two components: $c(\bar{x})$ and $m(\bar{x})$. $c(\bar{x})$ represents the direct energy cost, which is measured as the electricity cost; $m(\bar{x})$ is the indirect energy related cost.

The indirect energy related cost $m(\bar{x})$ needs to be modified if necessary for different problem to satisfy the specific problem's need. Since total energy cost is represented in annual dollar amount, indirect energy related costs also need to be amortized on a yearly basis.

Building energy analysis methods to evaluate the direct energy cost $c(\bar{x})$ include: degree-day methods, bin methods, building energy and systems simulations (Al-Homoud , 2001). Degree-day method and bin method has the advantage of simpler calculation; however these two methods are overly simplified, both in terms of the number of input parameters and inherent algorithm. As a result, energy consumption forecast often deviates much from the correct level. In this application, eCalc-Op will use eCalc for direct energy cost evaluation, which uses building energy and system simulation method. This offers better accuracy and abundance of input parameters that it can handle.

eCalc uses DOE-2 for building energy consumption prediction. As one of the leading building energy and systems simulation software, DOE-2 is developed at Lawrence Berkeley National Laboratory (LBNL), it utilizes hourly weather data to conduct hour-by-hour building thermo performance analysis based on building's input parameters data, such as building's geographical, dimensional, constructional, and HVAC system description.

However, simulation methods have their own drawbacks. First, it is computationally costly. For DOE-2, it takes about 2 seconds to do an analysis on a single-story, single-family building with a latest 3GHz Pentium IV computer; the computational time is even longer for more complex office building types. The other problem is, since it's a method based on simulation, there is no derivative information available, which is required by many optimization algorithms to find optimum.

IV.1.3 Constraints

Both (2) and (3) are constraints. (2) represents the lower bound and upper bound constraints for each decision variable (input parameter). (3) represents any other constraints necessary for the problem. For the list of lower bounds and upper bounds of the decision variables, please refer to Table 17 and Table 18 in APPENDIX A.

IV.2. Solution

The problem defined above is a typical optimization problem in operation research. Different solution algorithms can be adopted based on different characteristics of objective function and constraints. If both objective function and constraints are linear with respect to decision variables, the simplex method (Bazaraa, *et al.*, 2004) can be applied; for non-linear cases, if both objective function and constraints are differentiable and convex, derivative based search method can first be applied to find local optimum followed by using KKT condition (Ravindran, *et al.*, 1987) to test for global optimality.

In this problem, the objective function can only be computationally evaluated on a point by point basis by thermo analysis software simulation, therefore there is no derivative information available, and furthermore, initial test runs showed high nonlinearity and non-convexity, as shown in the figure on page 53. This type of highly nonlinear, non-convex optimization problem is called NP-Hard problem, which means there is no algorithms available to solve the problem efficiently. Under such circumstances, the only guaranteed way to find out optimum solution is through exhaustive search, which evaluates every possible point in the solution space. The weakness of this method is the computational time. For the problem under study, if there are only two decision variables: building orientation and air conditioning system efficiency, then, with a reasonable search step size for each decision variable, it takes about 4,000 evaluations to find optimum solution. Based on the fact that every evaluation is one iteration of DOE-2 simulation, the time it needs to find the optimum solution is about 2 hours on a Pentium IV 3 GHz computer. If there are 6 decision variables, the computational complexity will grow exponentially to more than 100 billion evaluations, which means more than 6,500 years of computational time on the same computer.

When finding the global optimum is not computationally impractical, researchers seek to use heuristics to address such problems. Heuristics are defined as “something that aids problem solving” (Sarker *et al.*, 2002). Any heuristic search algorithms must have two basic elements: (1) a local search to reach the local minimum; and (2) a global search to avoid being trapped in the local minimum. Three well know heuristics are (Pirlot, *et al.*, 1996) simulated annealing (Laarhoven and Laarhoven, 1987), tabu search, and genetic algorithms. Simulated annealing exploits the analogy to the annealing process of metals. Based on a random directional search, it allows the search direction other than decreasing objective function (here minimization problem is assumed) with a certain probability, and this probability decreases over time. By allowing searching in temporary deteriorating directions, the algorithm is able to escape local minimum and reach global optimum. Tabu search, on the other hand, adopts a different approach. It forbids the search in the direction that leads to places that the algorithm has visited before. Such structure can also prevent the algorithm being trapped in the local minimum. The third heuristic, Genetic Algorithms was proposed by Dr. John Holland in 1975. Based on the "the survival of the fittest" genetic algorithms mimics the natural selection process to find optimum solution.

IV.2.1 Genetic Algorithms

The problem under study has two characteristics: first, the problem is an optimization problem based on simulation, objective function can only be evaluated on a point by point basis, and no derivative information is available. Many search heuristics require objective function's derivative information to guide the algorithm's search direction, and this is simply not available in simulation based optimizations. Compared with those search heuristics, genetic algorithms don't have this drawback. Genetic algorithms generate better solutions by combining the "good qualities" of current solutions, which is totally independent of objective function's derivative information. The other advantage that genetic algorithms have is that their computational structure facilitates implementation of parallel computation. Parallel computation is an important means to improve an algorithm's efficiency and it is even more important for simulation based optimization problems as objective function value evaluation takes up most of the computation time. Adopting parallel computation can result in drastic reduction in computation time. The fundamental philosophy of most optimization heuristics is sequential improvement, which means the next solution is based on the outcome of the current solution. In comparison, genetic algorithm's structure is parallel implementation friendly: it works on a family of solution at the same time and those solutions are evaluated independently of each other. Such structure can boost genetic algorithm's performance through parallel implementation. As a result, a genetic algorithm is selected as the solution algorithm for eCalc-Op.

IV.2.2 Introduction of Genetic Algorithms

Genetic algorithms were first introduced by Dr. John Holland (1975) in 1975, and are based on Darwin's theory of evolution: the survival of the fittest. In natural environment, an individual's chance of survival depends on its traits and these traits are encoded in its genes. Through natural selection and competition, only the individuals with the fittest gene combination survive through generations.

Genetic algorithms use the same analogy in its algorithm design. Starting off with a family of solutions, and each solution in the family is functionally evaluated and their fitness is assigned through a fitness function. Solutions for the "next generation" will then be selected with the probabilities in accordance with their fitness values. Through this selection process, genetic algorithms are able to gradually improve on current solutions and move towards more optimum solutions. Besides gradual solution improvements, a good search algorithm must also be able to explore new areas in solution space. Genetic algorithms accomplish it through crossover and mutation operators. Crossover is the process through which surviving solutions exchange their own information contained within that of other solutions, and generate new solutions. Mutation modifies a current solution randomly thus new solutions can be drastically different. After crossover and mutation, the newly generated population of solutions will be evaluated again and passed to the next generation where another round of selection-crossover-mutation process begins. Similar to natural evolving processes, genetic algorithms can also continue endlessly. In order to stop the algorithm in time, genetic algorithms need to have some stopping criteria. The two most commonly used stopping criteria are either based on number of generations or convergence. The first criterion will stop the algorithm once a certain generation number is reached; the convergence criterion stops the algorithm if there hasn't been an improvement on current best solution for a certain consecutive number of generations. These two criteria can be used either separately or in combination.

A typical genetic algorithms program flow chart is shown in the following diagram (Figure 2) in pseudo-code:

```
Simple Genetic Algorithm()
{
        initialize population;
evaluate population;
while termination criterion not reached
{
                select solutions for next generation;
                perform crossover and mutation;
evaluate population;
}
}
```

Fig. 2. Simple genetic algorithm in pseudo code

IV.2.2.1 Genetic Algorithms Theoretical Background

Genetic algorithm has shown itself an efficient search heuristic through numerous applications. Its efficiency lies in the fact that, through its genetic operators (crossover, mutation) and selections schemes, the algorithms is actually able to "bias" its search in solution regions that yield better results. The theoretical explanation is the schema theorem proposed by Goldberg (1989).

A schema defines a subset of strings that possess certain patterns. For example, a 10 digit binary encoding, the schema H_1 is: 11********, representing all strings (encodings) with 1's in the first two digits and schema H_2 is: 1**0****** representing all strings with 1 in the first digit and 0 in the fourth digit. The order of a schema is the number of fixed digits a string contains and defining length is the span of the schema. For example, the above presented two schemas both have an order of 2, and with defining length of 2 and 4, respectively.

For example, in a 10-digit encoding:

Schema	Example	Order	Defining length
11********	*11*01100011, *11*10011100	2	2
1**1******	*1*10*1*100011, *1*00*1*010011	2	4

Assuming the following notations:

$P(H,t)$	Portion of the population that contain schema H at generation t.
$f(H,t)$	The fitness value of schema H at generation t. It's a positive number.
$\bar{f}$	The overall average fitness value at generation t.

In a generation, selection process happens first, followed by crossover and mutation process. Now define $t+\Delta t$ as the time epoch in generation t that is after selection but right before crossover and mutation, then, the portion of population contains schema H at $t+\Delta t$ is:

$$P(H,t+\Delta t) = P(H,t)\frac{f(H,t)}{\bar{f}} \qquad (4)$$

When the fitness value, *f*(H,t), of schema H is higher than the average fitness value, then, without considering the crossover and mutation effect, schema H will have an bigger proportion in the next generation.

Now, consider the crossover effect: in case of a crossover, a schema can either be destroyed or created, for example, the schema 11******** mentioned above will be destroyed if the crossover location is set at the first digit; on the other hand, schema11******** will be generated from schemas 1********* and *1******** if they crossover at the first digit. Now consider schema destroy effect and ignore creation effect, the portion of population containing schema H and generation $t+1$ is:

$$P(H,t+1) \geq (1-p_c)P(H,t)\frac{f(H,t)}{\bar{f}} + p_c\left[P(H,t)\frac{f(H,t)}{\bar{f}}(1-p_{destroy})\right] \qquad (5\ )$$

Where p_c is the crossover probability and $p_{destroy}$ is the probability a schema is destroyed. Now, denote:

$\Delta(H)$	Defining length of a schema length
L	The total length of a gene string

Then,

$$p_{destroy} = \frac{\Delta(H)}{L-1} \qquad (6\ )$$

Combine (5) and (6),

$$P(H,t+1) \geq P(H,t)\frac{f(H,t)}{\bar{f}}\left[1-p_c\frac{\Delta(H)}{L-1}\right] \qquad (7)$$

Now consider the mutation effect. Define p_m as mutation probability for each position in a chromosome, then, for schema H, the probability of surviving the mutation is:

$$p_{survival} = (1 - p_m)^{o(H)} \tag{8 }$$

Where p_m is the mutation probability. Since $p_m << 1$, $p_{survival}$ can be approximated as:

$$p_{survival} = 1 - o(H)p_m \tag{9 }$$

Revise (7) by adding (9), we have

$$P(H,t+1) \geq P(H,t)\frac{f(H,t)}{\bar{f}}\left[1 - p_c\frac{\Delta(H)}{L-1} - o(H)p_m\right] \tag{10 }$$

It can be seen that from for a given schema H, it is able to multiply as long as its higher fitness benefits out weigh the negative effects from crossover and mutation. Further observation reveals that genetic algorithms favor schemas with shorter defining lengths and higher fitness quality. Under schema theorem, optimum solution to the problem has the schemas with the best fitness; such schema therefore is able to increase in geometrical order in the population, which means genetic algorithms can quickly converge towards optimum.

However, schemata theorem is built upon several assumptions and their legitimacy is vulnerable to attack. Whitley (2001) pointed out inconsistencies exist in where multiple promising schemas have overlapping defining digits. For example for 2^{10} binary encoding schema 11******** and *00******* both have above average fitness value; however either can receive increasing population because they have conflict on the second digit. Problems also arise when population size is small. With a population size of 100, for a specific order-1 schema (e.g. ****1*****) the expected observation is 50; for an order-2 schema, the expected observation drops to 25, the number of observations drops exponentially as the schema order increases. This would severely damage the survivability of higher order schemas even if their individual fitness is above average. Real world practice shows genetic algorithm works very effectively in problems with higher consistency (marked with large regions with higher fitness value, such as a convex region), which supports schemata theorem; on the other hand, there are scholars who showed the entire schema processing may be wrong, although the theorem itself is true. Just as what Whitley put, there is still a great deal of work to be done to understand the role that schemata theorem plays in genetic search.

IV.2.3 Genetic Algorithms Application in Energy System Optimization

Genetic algorithms have been applied to different areas of energy consumption optimization. Most literatures appearing in this field pertains to HVAC system control strategies. The reason for this is that HVAC systems are highly non-linear in nature (Fong, et al., 2005), which makes GA a suitable tool to solve such problems. Based on a plant simulation tool, Fong *et al.*, (2005) applied genetic algorithms to locate optimum chilling water and supply air temperature settings for HVAC system. Caldas and Norford (2003) used genetic algorithms to schedule cooling and lighting reduction for HVAC system and produced satisfactory results. For solar energy, Chen *et al.*, (2005) applied genetic algorithms to find optimum installation angle for solar-cell panels. In Wright, *et al.*'s work (2002), they applied multi-criterion optimization and genetic algorithms to balance HVAC energy cost minimization and human discomfort.

Genetic algorithms have received limited applications in building energy optimization problems. In building structural design optimization, Caldas and Norford (2002) used GA to determine optimal sizing of windows and achieved satisfactory results. Wright *et al.* (2002) applied GA to optimize building thermal design and control. Both used building thermal analysis simulation as the tool to evaluate objective function; however, both failed to address the efficiency of the algorithm but rather focused on result analysis. Nassif *et al.* (2004) applied it to optimize HVAC system control strategy. The works to date have focused on determining and analyzing the solutions rather than on the algorithmic aspect of genetic algorithm's application on building energy cost optimization problems, such as algorithm design and analysis.

V. SOLUTION IMPLEMENTATION

In the previous section, the problem for the internship project was identified and a genetic algorithms approach was selected as the solution algorithm for the problem. In this section, implementation issues will be discussed. The organization of this section is as follows: First, the algorithmic aspect of the solution implementation will be discussed, then followed by programming implementation.

V.1. Genetic Algorithm Implementation

Genetic algorithms differ from other optimization algorithms in a way that they are more of a general principal, than a clearly defined, step-by-step algorithm. Therefore, genetic algorithms need to be implemented accordingly in different types of problems.

Genetic algorithms has five main elements (Gen and Cheng, 1996):

A genetic representation of solution to the problem;

A way to create an initial population of solution;

An evaluation function rating solutions in terms of their fitness;

Genetic operators that alter the genetic composition of children during reproduction;

Values for parameters of genetic algorithms.

For element (2), the initial population of solutions will be generated via randomly generating a family of solutions from solution space. This will ensure a diversified initial population with a good coverage of solution space. Element (1) refers to Genetic algorithms' encoding issue, element (3) refers to genetic algorithms' selection issue, and element (4) refers to the crossover and mutation operators in genetic algorithms. All these three issues will be explained in the following sections. Parameters of genetic algorithms in element (5) refer to variables that set the behavior of the algorithm. They include: population size, crossover rate, mutation rate, etc. Those parameters are important because proper values for those parameters can boost genetic algorithms' performance. Procedures on how to determine those parameter settings will be discussed in section VI. .

V.1.1 Encoding Issue

In genetic algorithm solutions must be encoded so that genetic operators can be applied. Encoding serves as the mapping from phenotype (the external manifestation) to genotype (the internal traits). According to Ronald (1997), properties of a good encoding methodology should:

Embody fundamental building blocks that are important for the problem type;

Be amenable to genetic operators that propagate these building blocks from parent generations to child generations.

Minimize epistasis (Ronald, 1997) where the effect of one gene suppresses the action of other genes.

Generate legal representation of the solutions.

Cover complete set of solution space.

Generate non-redundant mappings.

Examples of different encodings are: (a) binary encoding, (b) permutation encoding, and (c) real-number encoding.

Binary encoding appeared the earliest in Holland’s introduction to genetic algorithms (Holland, 1975). As discussed in Section 0, it represents the solutions as a string of zeros and ones. Permutation encoding uses integers as symbols to represent arrangement of objects of certain problems. One example of this permutation encoding is its application on the classic Traveling Salesman Problem. In Traveling Salesman Problem, each city is represented as an integer number, and an ordered list of the numbers is a representation of genetic algorithm solution. For example, for a 6-city Traveling Salesman Problem, six distinct numbers: 1, 2, 3, 4, 5, and 6 are used to represent 6 cities. Therefore, any permutation of the six numbers is a genetic algorithm solution with permutation encoding. Because of this permutation structure, it is widely used in combinatorial optimization problems.

Real-number encoding is the most straight forward. It simply represents the solution with real numbers. For example, for a functional optimization problem: maximize: $f(x)=3x^2$, $x \in [-3,3]$, any real number between -3 and 3 can be used to represent genetic algorithm genes. Practical experiences have confirmed real-number encoding outperforms other encoding methods in functional optimization and constrained optimization problems (Gen and Cheng, 2000). The problem under study was also a functional optimization problem, and initial experiments shows the objective function was continuous against most decision variables. As a result, real-number encoding is adopted.

V.1.2 Crossover Issue

As mentioned before, a good heuristic should be able to not only find local optimum efficiently but also avoid loosing the "big picture" and being trapped in the local optimum. Genetic algorithms does it through two genetic operators: crossover and mutation.

Each encoding method has its own family of crossover strategies. For binary encoding, the most famous crossover strategy is the one-point crossover used in Goldberg's book. When a crossover happens, the genetic algorithm picks two chromosomes (solutions), and cut the two binary strings of the two chromosomes at a random point, then exchange the remaining parts with each other.

For example, as shown in Table 2, there are two genes which represent solutions of 30 and 3, their binary encodings are 11110 and 00011, respectively. After a crossover at the second digit, the newly formed genes will be: 11011 and 00110, which represent solutions of 27 and 6.

Table 2. Example of a one point crossover

	Before crossover		After crossover	
No	Solution	Gene	Gene	Solution
1	$x = 30$	11 *110*	11 011	$x = 27$
2	$x = 3$	*00* 011	00 *110*	$x = 6$

For real encoding, most frequently used crossover technique is called arithmetical crossover (Gen and Cheng, 2000). It generates new genes through a linear combination. Here is how it works: For two given real-numbered genes x_1 and x_2, the new genes $x_1^{'}$ and $x_2^{'}$ will be:

$$x_1^{'} = \lambda_1 x_1 + \lambda_2 x_2 \tag{11}$$

$$x_2^{'} = \lambda_2 x_1 + \lambda_1 x_2 \tag{12}$$

Where λ_1 and λ_2 are multipliers. Usually, some restrictions are applied to the two multipliers:

$$\lambda_1 + \lambda_2 = 1 \tag{13}$$

$$\lambda_1 > 0, \quad \lambda_2 > 0 \tag{14}$$

The crossover becomes convex crossover under (13) and (14). Crossover for the problem under study adopted a special case of convex crossover where $\lambda_1 = \lambda_2 = 0.5$, which is called average crossover (Davis, 1991). Therefore, two identical new genes are generated as a result of the crossover between two parent genes, and these two genes are located at the middle point between two parent genes.

V.1.3 Mutation Issue

Similar to crossover, different mutation strategies are also based on their corresponding encoding methods. Most common mutation strategy used for binary encoding is simply flipping the binary bit at random on the string. For read encoding, mutation strategy ranges from the simple ones such as picking a new point within solution space at random, to more sophisticated methods proposed by Michalewicz (1996), which the generated new solution converges in probability to the current solution as generation proceeds. In our application, the first simpler mutation strategy is adopted.

V.1.4 Selection Issue

In selection process genetic algorithms picks the better individuals based on their fitness value. It provides a driving force in optimization. However the genetic search might progress either too slowly or end prematurely by being trapped in the local minimum if the force is too weak or too strong. Selection pressure should start off low and grows higher towards the end of genetic search (Sarker *et al.*, 2002).

In genetic algorithms, selection is made based on a gene's fitness value. Needless to say, fitness value has a very close tie with objective function value. For maximization problems the higher the objective function value the higher the fitness value, for minimization problem objective function value can also be easily translated to fitness value through some inverse transformation technique.

Roulette wheel selection was initially proposed by John Holland (1975). It sets an individual's survival probability equal to the ratio of its fitness value over overall fitness value. Thus the expected number of copies an individual has will be proportional to its fitness value. Despite the simplicity, this method has a drawback: for certain problems, the population tends to be dominated by several "super" individuals with high fitness values in early stage, and in later generations, competition among chromosomes is too weak and random search behavior will emerge (Gen and Cheng, 2000). To overcome this shortcoming, scaling mechanisms are adopted. Those scaling methods include: linear scaling, sigma truncation, power law scaling, logarithmic scaling, and so on. Besides scaling, ranking mechanism can also serves the purpose. Ranking, just as what its name indicates, is to rank the individuals according to their fitness value and determine their survival probability according to the ranking. Two ranking methods, i.e. linear ranking and exponential ranking are most commonly used. In our application, a more controlled scaling method – linear scaling is used.

V.2. Programming Realization

This section explains how genetic algorithms are implemented through computer programming. It is organized as follows: First, it will start with programming requirements, which specifies expected goals and functions the program has to achieve. In the next, because eCalc-Op's close relationship with eCalc, eCalc project's programming architecture will be introduced; finally followed by program structure design of eCalc-Op.

V.2.1 Programming Requirements

The consideration is, as a general purpose tool, eCalc-Op must be able to accept different inputs from different building optimization problems. As required in the project scope, three new building project models: single family, multifamily, and office building models are eCalc-Op's subject problems to solve. Even for problems for the same building model, the specific problem's requirement is also different, both in terms of number of decision variables and the constraints (lower bounds and upper bounds) of the decision variables.

Other factors that must be considered are algorithmic settings and general program settings. For the algorithm itself, those issues include genetic algorithm parameters settings (crossover rate, mutation rate, and population size), generation number, random number seed value, etc., and values for those parameters expected to be different in different applications. General program settings include input/out file and temporary file locations, SQL server connection string settings, etc. They are extremely useful in cases when program environment changes, such as when the program is migrated to another computer system, or input files are relocated, etc. These settings can be hard-coded in the program and it only needs to recompile the source code to put the changes in place, however, the best practice is to handle them in a way that those changes can be made on-the-fly without the need to recompile the program source code.

Last, and the most important, is the program output. Two different outputs are expected. The first is the general algorithmic output, expressed mostly in descriptive statistics.

Expected data are: average fitness in population, best fitness solution in population, worst fitness solution in population, standard deviation of fitness in population. The second is detailed algorithm output, in which decision variable and fitness values are expected for each solution in the population in all generations.

V.2.2 eCalc Architecture

Because eCalc-Op is using eCalc as its objective function evaluator, it’s necessary to explain how eCalc works programmatically before starting any discussion on eCalc-Op programming.

eCalc has three major components: (1) a Graphical User Interface (GUI); (2) a calculation component (referred to as CalcEngine), which estimates energy consumption based on the user input from GUI; and (3) a data storage component, which serves as both a hub and storage, transfers user input data and CalcEgine’s output data between GUI and CalcEngine.

The architecture of eCalc is presented in Fig. 3. On the user interface level, user selects one of the energy models, inputs required data, and submit the input data for calculation. Here each request for calculation is called a project, and input data is stored in an input file called project XML file, since the data is formatted according to Extensible Markup Language (XML) format protocol. For CalcEngine, the request for calculation is called a job. Apart from the project XML file.

GUI also writes two new entries into the database: One entry is written in project table describing some basic project information, such as model's code name, etc. The other entry will be written to job table, it serves as an indicator telling CalcEngine that there is a job waiting to be processed.

On the CalcEngine side, CalcEngine keeps querying the database to check if there are any new jobs for it to process. If there is, CalcEngine controller will then read project basic information from project datatable and project XML file stored on the data server. Then CalcEngine controller will send the job to different backend processing models based on the project's model type.

If the project is of new building models, CalcEngine controller will parse the data in project XML file and translate the input into a format DOE-2 simulation program can understand. Then DOE-2 simulation will be triggered by CalcEngine controller and after the job is processed CalcEngine will parse the DOE-2 output file and reformulated it into a job output file in XML format which is called job XML file.

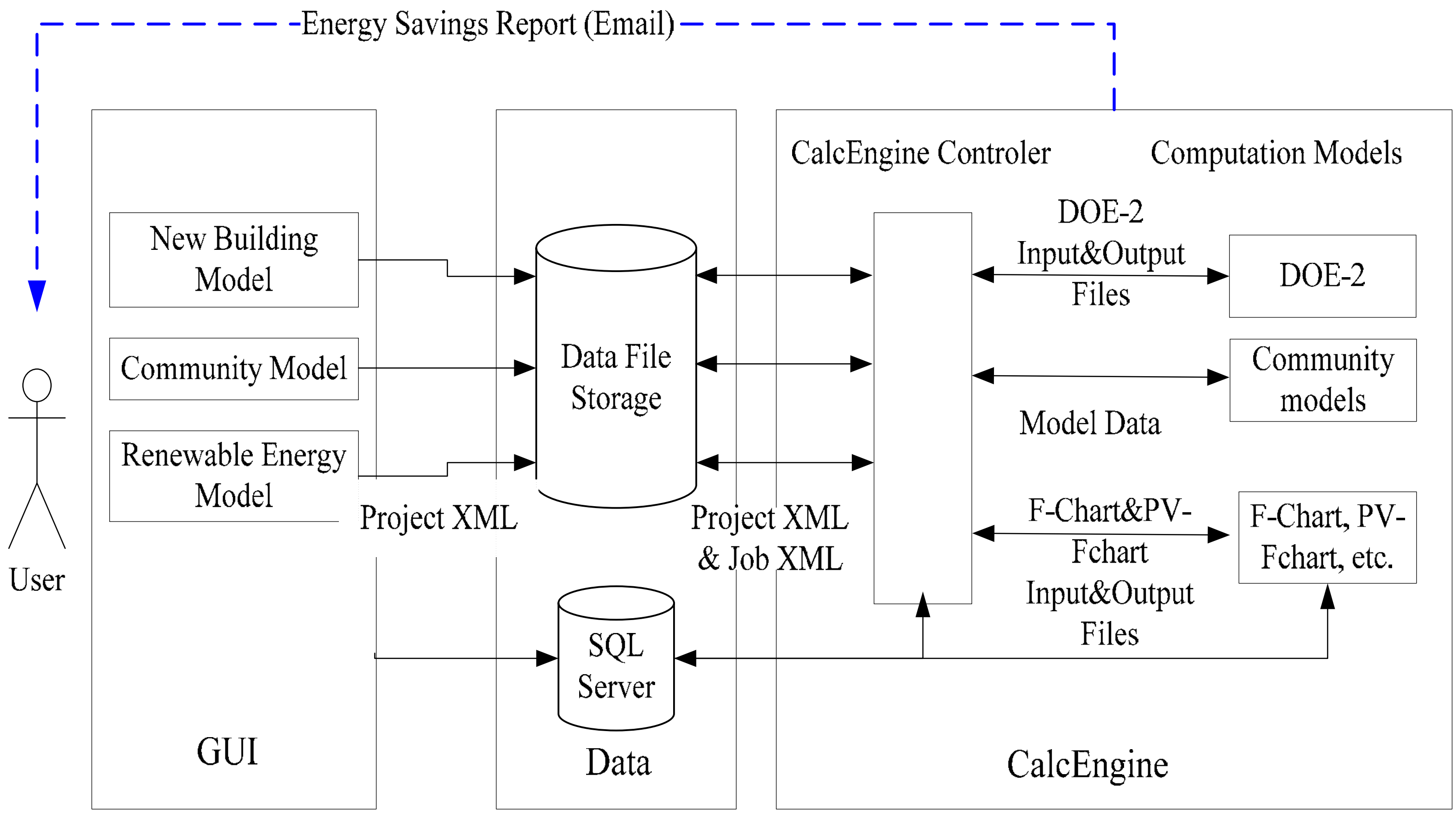

Fig. 3. eCalc diagram

For renewable energy projects, the process is similar all except the simulation is actually done by FChart and PV-Fchart. If the renewable energy project belongs to solar thermo model, CalcEngine will translate data in project XML into F-Chart input file and execute F-Chart simulation program. Then similarly CalcEngine will parse F-Chart output and reformulate it in to job XML file. On the other hand, if renewable energy project is of solar photovoltaic models, CalcEngine will generate PV-Fchart input file and trigger PV-Fchart simulation, followed by parsed PV-Fchart output file and reformulate it to job XML.

For the rest of the models, the calculation processes are much simpler since they can be handled within CalcEngine, with no need to rely on third party simulation programs. For all of eCalc's project types (new building projects, community projects, and renewable energy projects), the final result is presented to the user via email. Although job XML contains all the output data needed in the final report, as a data format that is designed to only facilitate data exchange, job XML files are not for viewing. As a result, CelcEngine reformats job XML by generating report in HTML format and subsequently send it the user. A detailed eCalc flow chart is provided in Fig. 4.

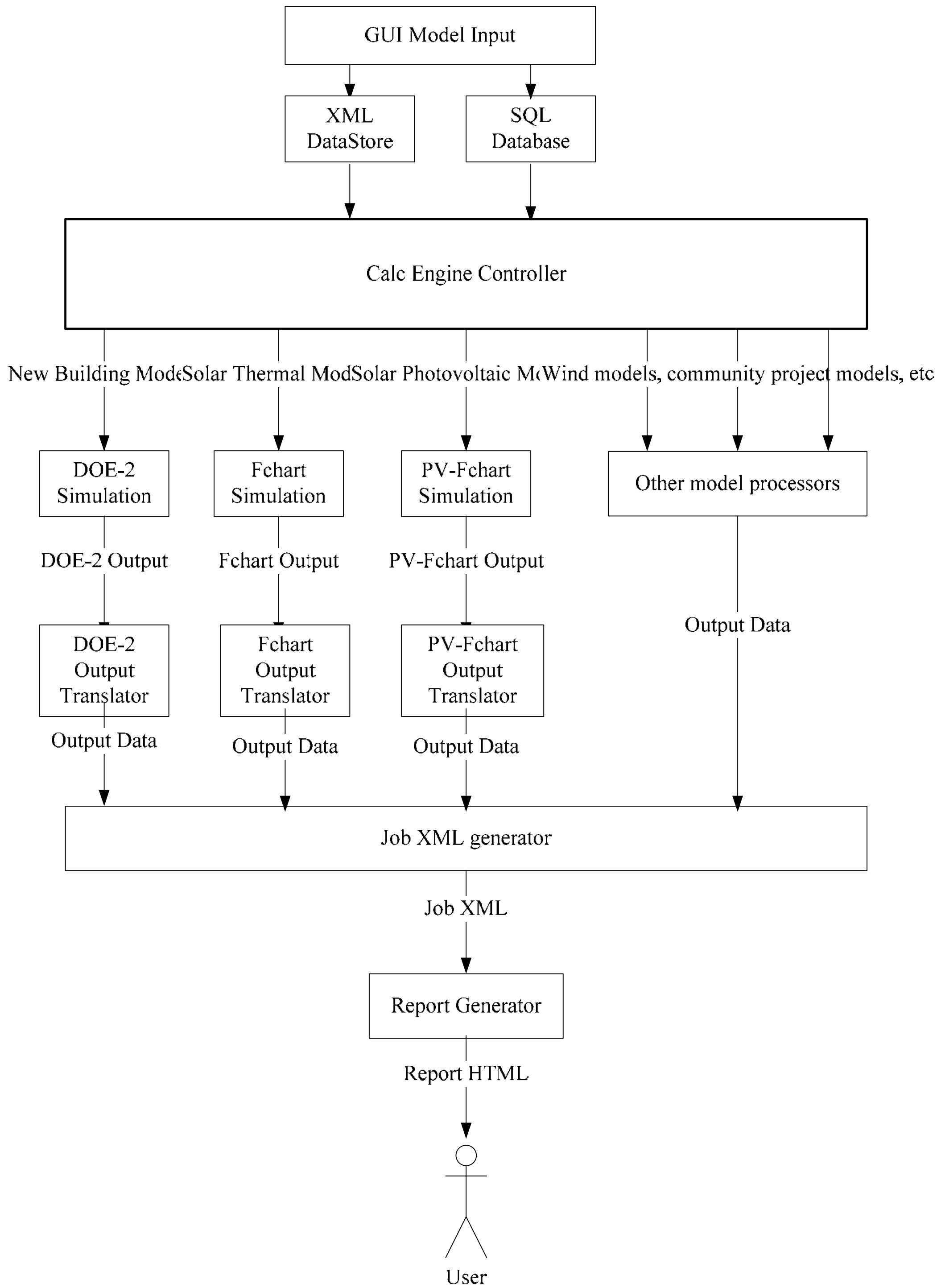

Fig. 4. eCalc flow chart

V.2.3 eCalc-Op Program Structure

In order to satisfy the programming requirements, two programming guidelines are to be followed in eCalc-Op program structure design:

Separation of data and code. Program requirements have put a very high level of demand on flexibility: Not only the program has to be able to optimize energy consumption on three different buildings models; even for the same building model, the number of decision variables (parameters) and constraints are different with different problems. Therefore, problem data must be separated from the code so that the program needs not to be recompiled when switching problems.

Separation of program settings data from code. Apart from problem data, the other issue to consider is the program environment settings. Those settings include: problem data file name and location, general genetic algorithm settings, such as population size, mutation rate, etc., output file name and location, etc. Similarly, those settings should also be kept separate from the program.

V.2.3.1 Program Structure

Fig. 5 is a structural overview of eCalc-Op and its relationship with eCalc, with the left side being eCalc-Op and right side eCalc.

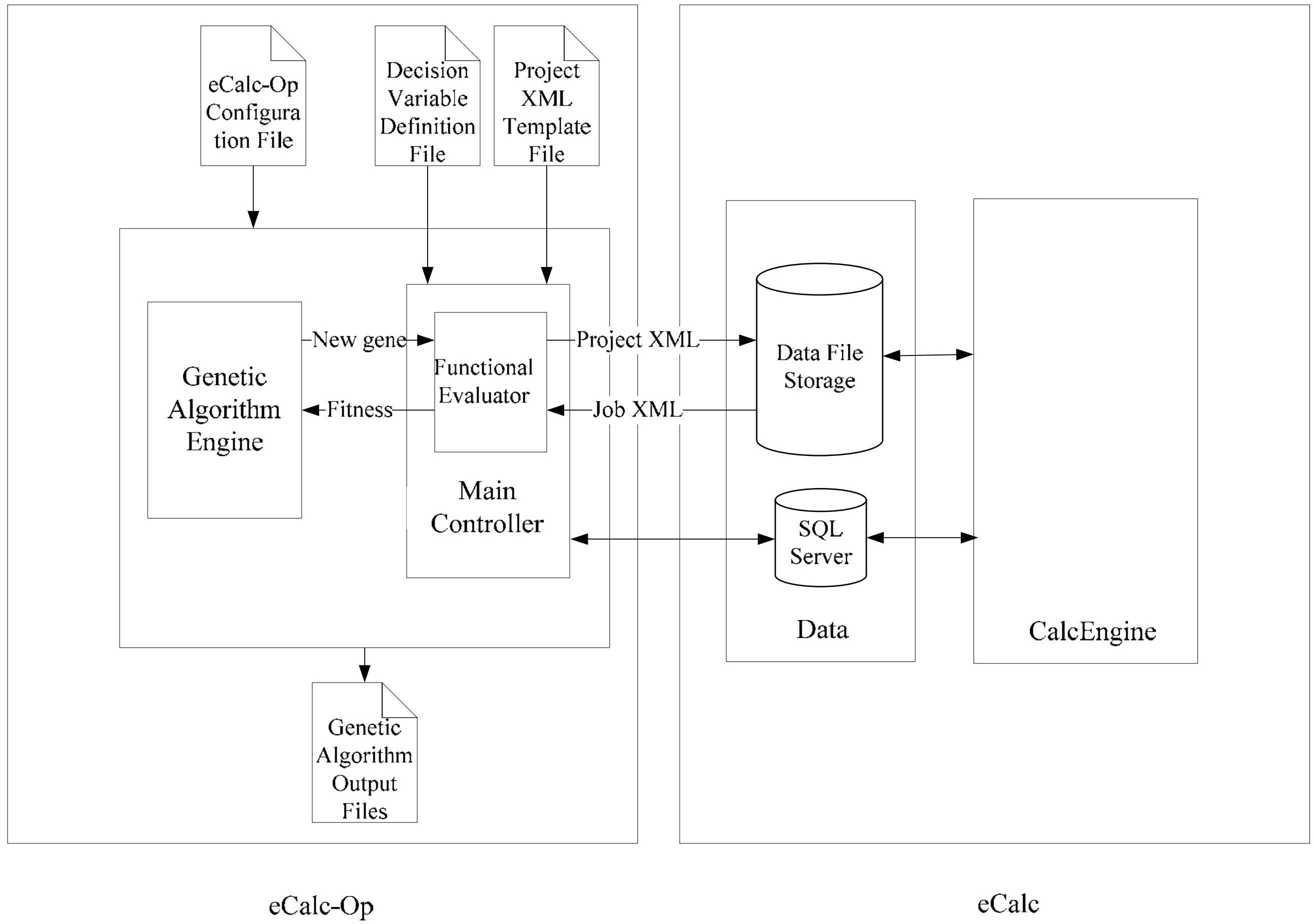

Fig. 5. eCalc-Op structure

It can be seen in the figure that eCalc-Op utilizes two major components (database and CalcEngine) of eCalc for objective function evaluation. eCalc-Op has two main components: a main controller and a genetic algorithm engine. Genetic algorithm engine is based on Matthew Wall's GA Library (Wall, 2005), with some modification tailored to eCalc-Op's need. The main controller serves as moderator between genetic algorithm engine and eCalc. Besides, there are three input files controlling eCalc-Op's behavior, they are: eCalc-Op configuration file, decision variable definition file, project XML template file.

The eCalc-Op configuration file specifies general eCalc-Op's program settings, such as the problem's building model type, SQL Server connection string, path and file name of the input files, etc., along with several genetic algorithm parameter settings, namely, population size, total generation number, mutation rate, crossover rate and random number seed value. Decision variable definition files store the list of decision variables and their constraints (lower bound and upper bound) information. In order to let eCalc calculate energy consumption, knowing only the values of decision variables is not enough. Other eCalc input parameters are also indispensable for energy consumption estimation. For example, for five decision variables problems, the five decision variables are building orientation and length of the eaves on each side of the building. In order to evaluate the building's energy consumption, other non-decision variables information, such as building size, wall and roof building material, HVAC system setup, etc. must also be provided in order to generate project XML for eCalc to predict energy consumption. eCalc-Op uses a project XML template file to store those input parameters and their settings. Furthermore, just as its name implies, it also serves as a template for the project XML file to be sent to eCalc. Since each project XML template file is a full-blown project XML, thus the eCalc-Op controller only needs to duplicate the project XML template file and fill in the values for decision variables to generate its own project XML file. Detailed descriptions on those files will be shown in the following sections.

Finally, to output the genetic algorithm's result, eCalc-Op generates two output files. One contains a detailed record of every gene and their fitness value for all generations. The other one is a summary file containing some descriptive statistics of genetic algorithm by generations, such as average, best, and worst fitness value of the population.

Fig. 6 is a flow chart describing how eCalc-Op works. First, it initializes genetic algorithm genes with the information read from the decision variable definition file. Then, genetic algorithm related parameters (population size, total number of generations, etc) are initialized with information from and eCalc-Op configuration file. Finally, the main controller will start the genetic algorithm's iterative optimization process until certain stopping criteria is satisfied.

V.2.3.2 eCalc-Op Input/Output Files

In this section, a detailed description on the input/output files will be given. It's important to understand the format and content definition of those files since they define what eCalc-Op does.

All the input files follows XML format. For a more information about XML, please refer to Ray (2001). Both output files are in plain txt format.

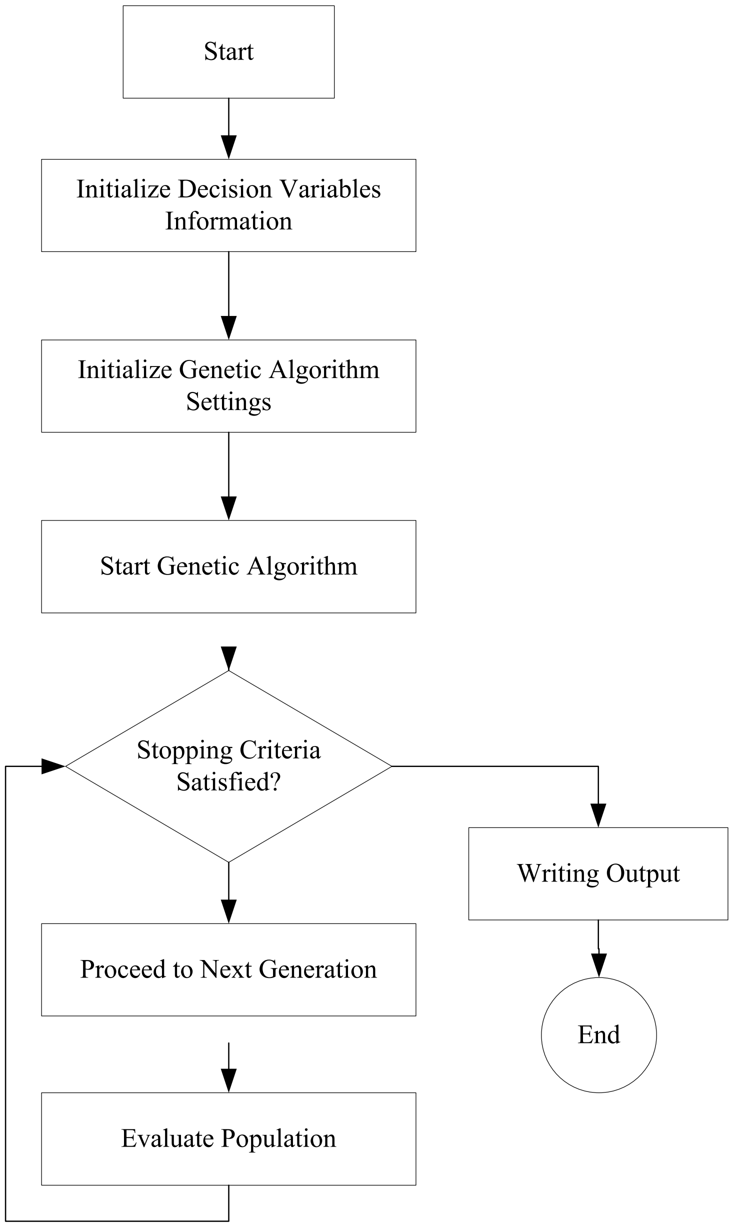

Fig. 6. eCalc-Op flow chart

V.2.3.3 eCalc-Op Configuration File

Fig. 25 in APPENDIX B is a sample eCalc-Op configuration file The file name is always defined as the name of the eCalc-Op executable file name plus ".config"as file extension. For example, if the program executable file name is "eCalc-Op.exe" then the configuration file name needs to be "eCalc-Op.exe.config". When the user double clicks the executable file and starts the program, the eCalc-Op program will always search for configuration file with this name for configuration information.

There are several Config Sections in each in each configuration file. The purpose for having different Config Sections is to facilitate the different computing environments eCalc-Op might be running in. For example, there might be different types of problems the program needs to work on, each type of problem has its own input files located in different system folders. Thus, when switching problem types, user only needs to change the ConfigSectionName under appSettings node to corresponding Section Group name defined under Config Section node, without the need to rewrite the whole configuration file.

All useful eCalc-Op configuration information are contained under each Config Section. To further categorize configuration information, each Config Section is divided into three sub sections : COMMON, XML and GAPARAM.

COMMON sub section contains the general eCalc-Op program configuration settings. It has 10 keys, and their explanations are summarized in Table 3:

Table 3. COMMON sub section description

Key	Description
Scenario	The model name code. SNGFAM2ST for single family building, MULTFAM for multi-family building, OFFICE for office building
ConnectionString	The connection string for SQL Server connection
XMLProjPath	The location where the project XML files will be stored.
XMLJobpath	The location where the job XML file will be stored
TempFile	The location where temporary file will be stored
ErrorLog	The full path and file name of the error log file
DataDirectory	The path where temporary data file will be stored
GASummaryFile	The full path and name of the genetic algorithm output summary file
GAOutputFile	The full path and name of the genetic algorithm out put file
IncludeCost	Whether the indirect energy cost should be included. The value is either true or false.

XML sub section stores the other two input files' location information, and they are summarized in Table 4:

Table 4. XML sub section description

Key	Description
ModelProjectXMLPath	The full path and name of the project XML template file
OPParamXMLPath	The full path and name of the decision variable definition file

GAPARAM sub section contains some genetic algorithm parameters, as shown in Table 5.

Table 5. GAPARAM sub section description

Key	Description
Population	Population size of genetic algorithm, must be integer
Generation	Maximum generation number, must be integer
pMutation	Mutation rate, must be between 0 and 1
pCrossover	Crossover rate, must be between 0 and 1
Seed	The seed value for random number generator, must be integer

V.2.3.4 Decision Variable Definition File

Decision variable definition file also follows XML format, and a sample decision variable definition file is shown in Fig. 7.

As shown in Fig. 7, each decision variable is defined under the node name tblOPParam, and a detailed definition of each sub-node is shown in Table 6.

Table 6. Decision variable definition

Node Name	Description
Name	Name of the decision variable, it must be consistent with the parameter name defined in project XML template file
Section	The section name which the parameter is under in project XML template file
Min	Minimum value
Max	Maximum value
Value	Starting value
DataType	Date type, “int” if the decision variable is of integer type, “double” if it’s of double type
Step	The increment to be used in search

```xml
<?xml version="1.0" standalone="yes"?>
<OPParamDT xmlns="http://tempuri.org/OPParamDT.xsd">
  <tblOPParam>
   <Name>b03</Name>
   <Section>BLDG1</Section>
   <Min>0</Min>
   <Max>360</Max>
   <Value>0</Value>
   <DataType>int</DataType>
   <Step>1</Step>
  </tblOPParam>
 <tblOPParam>
   <Name>sy04</Name>
   <Section>SYST1</Section>
   <Min>8</Min>
   <Max>20</Max>
   <Value>10</Value>
   <DataType>int</DataType>
   <Step>1</Step>
  </tblOPParam>
</OPParamDT>
```


Fig. 7. Sample decision variable definition file

V.2.3.5 Project XML Template File

Project XML template file itself is a legitimate project XML file. It not only provides eCalc-Op a template for generating its project XML file, but also specifies what values to use for non-decision variables in project XML file. Fig. 26 and Fig. 27 in APPENDIX B are two project XML template files used in two case studies later in this report. Because the structure of project XML template file is identical to that of eCalc new building model project XML files, the description of project XML template file will not be covered in this record of study.

0	1516.47	1878	1207.7	180.179
1	1472.83	1963.1	1162.4	208.306
2	1457.34	1984.8	1162.4	217.875
3	1450.4	1984.8	1152.5	202.272
4	1403.8	1759.5	1152.5 1	59.964
5	1410.82	1856.5	1152.5	164.572

Fig. 8. Sample genetic algorithm summary output file

V.2.3.6 Output Files

Genetic algorithm will generate two output files. One is an output summary file and the other is a detailed output file. Fig. 8 shows part of a sample output summary file, and its column definitions are explained in Table 7.

Table 7. Genetic algorithm summary output file definition

Column	Definition
1	Generation number
2	Average fitness in population
3	Worst fitness in population
4	Best fitness in population
5	Standard deviation in fitness

Detailed output file is holds all the solutions processed by genetic algorithm. Fig. 9 shows part of a sample detailed output file. The first line of the file displays the column definition of the file. The first column is the generation number, and last column is the objective function value. Columns in between are values of decision variables. For example, in Fig. 9, "Gen" is the generation number, and "b03", "sy04", "c21", "c22", "c23", c"24" are the eCalc internal names for the decision variables and they represent building orientation, air conditioning system cooling efficiency, front, back, left and right window-to-wall ratios. Lastly, "Fitness" is the fitness value for that solution. For instance, the first data row displays a solution in generation 0. With building orientation = 165, air conditioning system cooling efficiency (SEER value) = 10, front, back, left and right window-to-wall ratio = 74%, 53%, 16%, and 27%, the total energy cost = $1818.60 per year.

Gen	b03	sy04	c21	c22	c23	c24	Fitness
0	165	10	74	53	16	27	1818.6
0	235	13	17	47	39	19	1209.2
0	325	15	55	70	14	15	1460.7
0	140	12	50	24	34	36	1526.8
0	300	12	63	54	20	40	1597
0	125	12	75	55	27	78	1816.9
0	205	20	70	32	18	38	1610.6
0	275	15	74	28	78	16	1661.7

Fig. 9. Sample genetic algorithm log file

VI. RESULTS & DISCUSSION

After the programming part of eCalc-Op is accomplished, there are still two issues left. First is to determine the values for several genetic algorithm parameters. Second is to evaluate the algorithm's efficiency.

As mentioned before, genetic algorithms' properties requires that: (1) the algorithm works on a population solutions rather than on a single solution at a time; (2) genetic operators, namely crossover and mutation, be applied to the family of solutions. Population size defines how many solutions, or the size of the solution pool, a genetic algorithm has in a generation. Crossover rate determines the likelihood that a solution will crossover with another. And mutation rate determines the likelihood that a mutation would occur on a solution.

Therefore, the first step is to identify the ideal settings of those parameters. Unfortunately, there is no theoretical guidance on how to determine those values (Yang, *et al.*, 2000). In practice, they are mostly carried out on a trial by trial basis. Furthermore, those parameter values are also heavily problem dependant. Even for the same type of problem, a set of parameter values that work well for one specific of problem might cause the algorithm to underperform in another.

As a result, for then problem under study, the process of determining the parameter settings was explained through two cases studies. And the purpose of the two case studies was to provide a guideline on how those parameter settings should be determined. Here as a precaution, it is worthwhile to point out that the optimum values of the parameters in the two case studies are only applicable to the two case study problems. If the problem changes, the values of those parameter settings must be reevaluated using the procedure.

In the following sections of this section, it will first start with the cases setup, followed by the analysis on the genetic algorithms parameters. Finally the genetic algorithm's performance will be evaluated.

VI.1. Case Study Setup

Based on the input parameters eCalc needs, both test cases used an imaginary, typical single family house located in Tarrant County, TX, which is representative of a hot climate zone. The building had a width and depth of 60 feet and 30 feet, with only one story. Rest of the eCalc input parameters were all set at their default value as specified in eCalc spec sheet, as shown in Fig. 25 and Fig. 27 of APPENDIX B.

The first case was a two decision variables case and the second was a six decision variables case. First case selected building orientation (unit: degrees) and air conditioning system cooling efficiency (unit: SEER) as the decision variables. Building orientation ranged from 0 degrees (facing south) to 360 degrees, and the range of SEER value of air conditioning system cooling efficiency was between 8 and 20, with 8 being the least efficient and 20 the most efficient. The reason why these two parameters are selected was that the non-monotone behavior of building orientation against building energy consumption, and the interaction between orientation and SEER value made the objective function become non-convex and unpredictable. Initial test runs have shown optimum energy cost point always converges to the maximum SEER value, i.e. SEER=20. In order to “complicate” the problem and “drive” the global optimum away from the boundary of constraints, a life-cycle cost for an air conditioning system was introduced into the objective function as the indirect energy cost.

Assuming a \$0.10/kWh electricity cost and a 10 year life cycle for air condition unit, the objective function is expressed in annual total energy cost as follows:

$$\min : z = 0.1 \cdot e(d, s) + \frac{k(s)}{10} \tag{15}$$

Subject to:

$$\begin{aligned} &0 \le d < 360 \\ &8 \le s \le 20 \end{aligned} \tag{16}$$

where

$e(d, s)$ is the annual electricity consumption in kilowatt hours (kWh), which can be directly evaluated through DOE-2.

$k(s)$ is the A/C system installation cost

d is orientation

s is SEER value as air conditioning system cooling efficiency

For installation cost, from empirical data, the most common capacity of air conditioning system for single family house is 3-ton, and the installation cost is summarized in Table 8 as follows:

Table 8. Single family air conditioning system installation cost

SEER	Cost
10	$1200
12	$2000
14	$3200
19	$5300

With a simple linear regression, the cost function is approximated as:

$$k(s) = -1483 + 260 \cdot s \qquad (17\ )$$

substituting the term $k(s)$ in (15) with (17) results in the new form of objective function:

$$\min : z = 0.1 \cdot c(d,s) + \frac{-1483 + 260 \cdot s}{10} \qquad (18\ )$$

For the two decision variables case, although genetic algorithms doesn't offer much advantage n terms of computational effort it needs to solve the problem over an exhaustive search, it has two major benefits: (1) it is the only realistic way to identify the global minimum within the solution space. As mentioned earlier, it only takes two hours of computational time for an exhaustive search to find optimum, increasing the problem size even by one more dimension would render to problem too costly to solve. Besides, (2) it is also easier to present the result graphically for two decision variables case. The result of exhaustive search is shown in Fig. 10. Optimum solution is found at Azimuth=357 and SEER=11, with a total energy cost =$1157.70 per year.

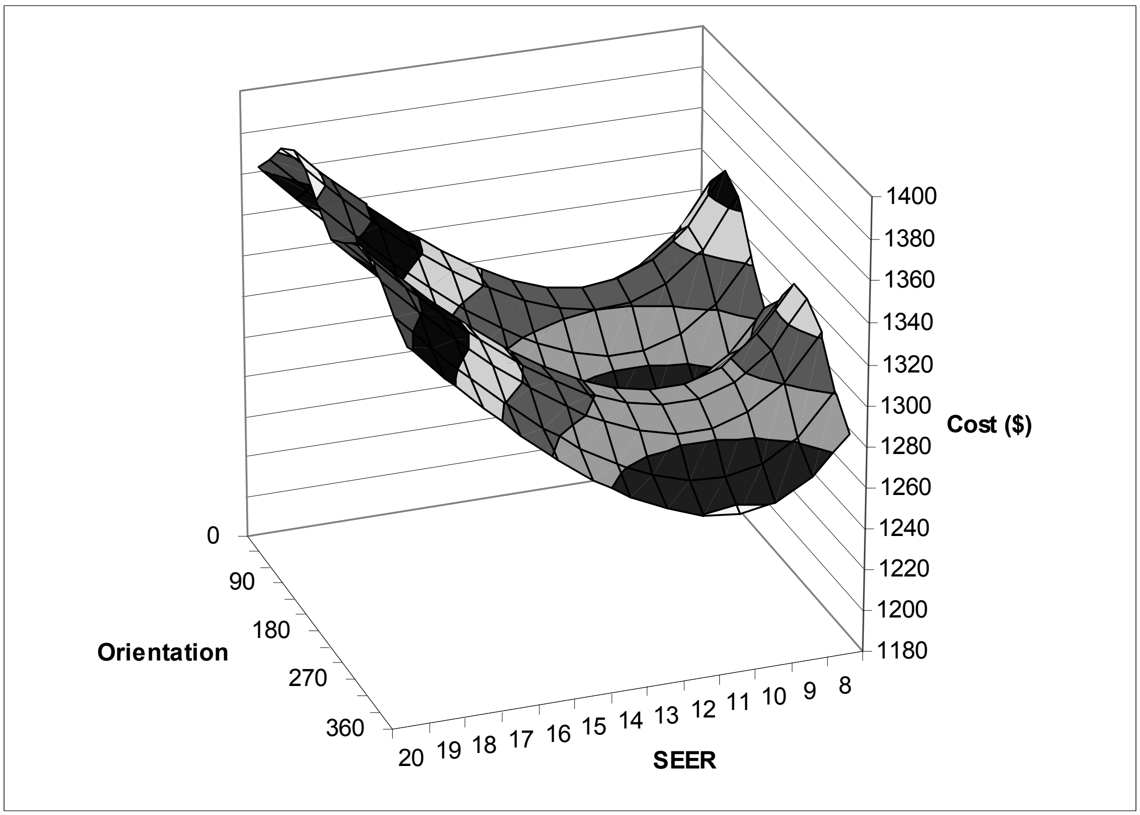

Fig. 10. Two decision variables total energy cost

The six decision variables case aims to test the genetic algorithm's performance under more complex situations. However, finding the global optimal is computationally prohibitive. With an exhaustive search, it will take around 6,500 years to find optimal solution with a Pentium IV 3GHz computer. Since finding the optimal solution is not possible for a general six parameter case, a special case is created so that global optimum can be found analytically. In the six parameter case, four selected window-to-wall ratios are independent of each other, and their interactions with the rest two parameters (building orientation and A/C cooling efficiency) are also weak.

The case problem formulation is shown as follows:

$$\min : z = 0.1 \cdot c(d, s, w1, w2, w3, w4) + \frac{m(s)}{10} \tag{19}$$

Subject to:

$$\begin{aligned}
&0 \le d < 360 \\
&8 \le s \le 20 \\
&10 \le w1 \le 80 \\
&10 \le w2 \le 80 \\
&10 \le w3 \le 80 \\
&10 \le w4 \le 80
\end{aligned} \tag{20}$$

where $w1, w2, w3, w4$ are front, back, left and right window to wall ratios.

Under the current building location setting, all four window to wall percentages should converge to their minimum value at optimum. In optimal solutions, building orientation and air conditioning cooling efficiency should also be similar, if not the same, as in the two decision variables case. Under above assumptions, the location of global minimum should be at or close to the neighborhood of building orientation = 357 degrees, air conditioning system cooling efficiency = 11 SEER, and with all window to wall percentages at 10%. A "localized" exhaustive search in the neighborhood of above mentioned solution has identified the global minimum at: orientation = 357 degrees, air conditioning system cooling efficiency = 10 SEER, and all window to wall percentage = 10%. The total energy cost at optimum is $1,120 per year.

VI.1.1 Genetic Algorithm Parameters Analysis Setup

Analysis of the effects of genetic algorithm parameters: population size, crossover rate, and mutation rate was conducted on the both cases through a series of experiments. Due stochastic nature of genetic algorithm itself, each experiment setting is replicated 10 times with different random number streams. Based on De Jong's study (De Jong, 1975), ranges of those parameters are: population sizes between 5 and 100, crossover rates between 0.1 and 1, and mutation rate between 0.01 and 0.1.

For population size, while fixing crossover rate at 0.9, mutation rate at 0.01, experiments with different population sizes of 5, 10, 20, 50 and 100 are conducted.

For crossover rate, experiment settings of crossover rates = 0.3, 0.5, 0.7, 0.9, with population size = 50 and mutation rate set at 0.01 are used.

Similar experiments are also set for a mutation rate of 0.01, 0.05, 0.07, and 0.10, while keeping population size = 50 and crossover rate = 0.9.

The above experiment settings are conducted on both the two decision variables case and the six decision variables case, with the difference only in generation number. As mentioned in previous sections, there are two stopping criteria in genetic algorithm, it's either based on generation number or base on convergence. Since the purpose of the experiments was on the genetic algorithm parameters, generation number based criterion is used since in that case the algorithm's run time is more predictable. Due to the limited computational resource available, generation number of 200 was only adopted in cases with population size of 50 and under, and it's reduced to 100 when population size is 100. As a summary, Table 9 contains all the experiment settings for both cases. There are 13 settings in each case and totally 260 experiments are conducted, which means an approximately 60 days of computation time on a 2GHz AMD computer system.

Table 9. Experiment settings for case studies

Parameter	Population Size	Crossover Rate	Mutation Rate	Replications	Generation Number
Two Decision Variables Case					
Population Size	5, 10, 20, 50, 100	0.9	0.01	10	100 or 200
Crossover Rate	50	0.3, 0.5, 0.7, 0.9	0.01	10	200
Mutation Rate	50	0.9	0.01, 0.05, 0.07, 0.10	10	200
Six Decision Variables Case					
Population Size	5, 10, 20, 50, 100	0.9	0.01	10	100 or 200
Crossover Rate	50	0.3, 0.5, 0.7, 0.9	0.01	10	200
Mutation Rate	50	0.9	0.01, 0.05, 0.07, 0.10	10	200

VI.2. Statistical Analysis Procedures

Genetic algorithm uses the best solution in the population of a generation as the algorithm's solution for that generation, and the subject of statistical analysis is the genetic algorithm’s solutions. Because of the non-deterministic nature of genetic algorithm, the result from a single run, or the average of several runs, is not enough to draw the conclusion on the performance of the algorithm. Therefore, experiment data must be analyzed statistically before deriving any valid conclusions.

The statistical analysis procedure on each parameter has two steps. The first step is to test whether the genetic algorithm’s responses to different parameter settings differ statistically. If the difference is not significant, it indicates different settings of the parameter under study don’t have an impact on the genetic algorithm’s performance and the analysis will complete. Otherwise, more statistical test is necessary to identify which parameter setting(s) leads to best genetic algorithm performance (highest response).

One-way ANOVA (Analysis of Variance) is suitable for the analysis in the first step. In ANOVA, the variable that forms the grouping is called independent variable (Ravindran, et al., (1987)). For the test cases, the genetic algorithms parameters were independent variables, and different values for those parameters were referred to as levels. For example, the genetic algorithms parameter population size is an independent variable, and population sizes of 5, 10, 20, 50 and 100 are 5 different levels of the independent variable. Since the ANOVA statistical analysis only studies on one independent variable at a time, the ANOVA procedure is called one-way ANOVA. One-way ANOVA allows us to test the null hypothesis that the means of the best solution found in a given generation are the same regardless of the genetic algorithm parameter’s different settings (levels). A detailed one-way ANOVA analysis setup is described as follows:

For a statistical analysis on a given genetic algorithms parameter, first define the following notations:

N Total number of generations, it's either 100 or 200

K Number of levels of treatments of the given genetic algorithms parameter

R Total number of replications for each treatment level

x_{ikl} The value of the best solution found at i th repetition , k th treatment level of l th generation, where $i = 1,2,...,R$, $k = 1,2,...,K$, and $l = 1,2,...,N$

μ_{kl} The real mean of the best solution at k th treatment level, l th generation, where: $k = 1,2,...,K$ and $l = 1,2,...,N$

Then for a given generation l , the null and alternative hypothesis are stated as follows:

$H_0 : \mu_{1l} = \mu_{2l} = ... = \mu_{Kl}$

$H_1 : \mu_{il} \neq \mu_{kl} \quad for \quad some \;\; i, \;\; k$

Now, further define

$\overline{X}_{kl}$ Average of x_{ikl} of level k , generation l

$\overline{X}_{l}$ Overall average of generation l

SS_{Bl} Sum of squares between levels in generation l

SS_{Wl} Sum of squares within a level in generation l

MS_{Bl} Mean square error between levels in generation l

MS_{Bl} Mean square error within levels in generation l

Here,

$$SS_{Bl} = \frac{1}{R}\sum_{k=1}^{K}(\overline{X}_{kl} - \overline{X}_{l})^2 \tag{21 }$$

$$SS_{Wl} = \sum_{k+1}^{K}\sum_{i=1}^{R}(x_{ikl} - \overline{X}_{kl})^2 \tag{22 }$$

And test statistic is defined as:

$$F = \frac{MS_{Bl}}{MS_{Wl}} = \frac{\frac{SS_{Bl}}{K-1}}{\frac{SS_{Wl}}{(R-1)K}} \tag{23 }$$

If value of the test statistic in (23) is smaller than the critical value, it indicates the null hypothesis is true. In this case, no further statistical analysis is necessary, since the genetic algorithms' response is not sensitive to the parameter under study at all. If the test statistic value is larger than the critical value, it implies the genetic algorithm's response to at least one of the parameter values is different than others. In this case, further statistical test is necessary to identify the parameter value(s) that have the highest response.

For the second step, multiple-comparison procedures are needed to find the best parameter setting. Among these are Tukey method (also called HSD method, Honestly Significant Difference method) and NewMan-Keuls method (Maxwell and Delaney, 2004). Both are designed to make all possible pair wise comparisons between treatment levels. However, these methods are inefficient since what is of interest here are the comparisons with the best level, not the comparisons between every possible pairs. Therefore, Hsu's method (Maxwell, et al., 2004) is adopted. Hsu's procedure is also called multiple comparisons with the best (MCB) procedure, it is suitable for identifying the best treatment level or levels among the treatments. The application of the procedure is as follows:

Define $\bar{x}_{kl}$ as the sample treatment level k in generation l

Now, for generation l, define D_{kl} as the difference between each treatment level mean $\bar{x}_{kl}$ and the smallest mean of remaining treatments (it will be referred to as test statistic later in the section) as:

$$D_{kl} = \bar{x}_{kl} - \min_{j \neq k}(\bar{x}_{jl}) \quad for\ i = 1, 2, \ldots, K \tag{24}$$

Now the lower bound L_{kl} and upper bound U_{kl} at 1-α level of confidence interval are as follows:

$$L_{kl} = D_{kl} - M_l \tag{25}$$

$$U_{kl} = D_{kl} + M_l \tag{26 }$$

where half width M_l is:

$$M_l = d_{(\alpha, K-1, N-K)} \sqrt{\frac{2s^2}{R}} \tag{27 }$$

In equation (27), $d_{(\alpha, K-1, N-K)}$ is the tabled statistic for one-sided comparisons with level of α, $K-1$ and $N-K$ degrees of freedom, and s^2 is the mean square error calculated as:

$$s^2 = \frac{\sum_{k=1}^{K}\sum_{j=1}^{R}(x_{jkl} - \bar{x}_{kl})^2}{N-K} \tag{28 }$$

Two inferences can be made from this Hsu's procedure: The first inference is "the treatment is, with 95% confidence level, NOT the treatment with the lowest treatment mean", and this corresponds to the situation when the lower bound $L_{kl} > 0$. The other inference is "the treatment under study IS the best treatment with the lowest treatment mean", which corresponds to the case when $U_{kl} < 0$. Detailed explanation is as follows in Fig. 11:

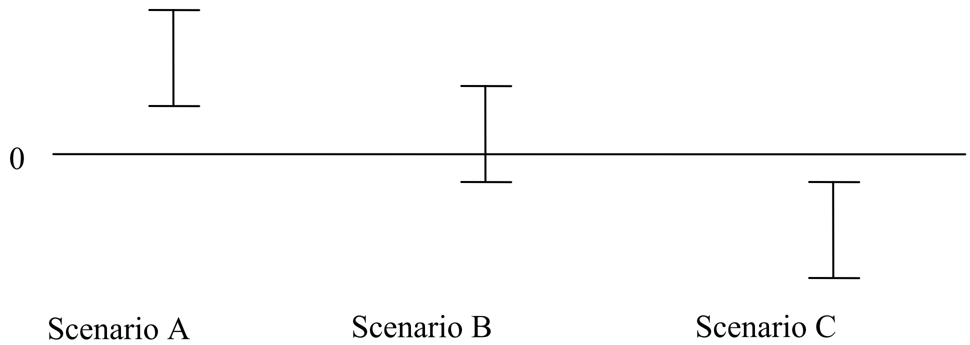

Fig. 11. Three possible outcomes of Hsu's procedure

The purpose of the test statistic D_{kl} is to compare the difference between the true mean of the treatment level with the minimum of the true mean of the rest of the treatment levels. If this difference is greater than zero, it means the treatment level is not the smallest (best); and the treatment level is the smallest (best) if otherwise. However, due to the nature of randomness, the true difference between the means is unknown, only confidence intervals on the difference can be constructed using experiment data. Fig. 11 provides 3 scenarios of the confidence interval. In scenario A, the lower bound of the confidence interval is above zero, since the true difference between means lies in this interval with certain (usually 95%) confidence level, we can make the inference that this difference is greater than zero and therefore the treatment level is not the best. In this case, both of inference are "TRUE". On the other hand, in scenario C, the upper bound of the confidence interval is less than zero, and this corresponds to the case that the treatment level does have the smallest response. In this case, the first inference is "FALSE" and the second is "TRUE". In scenario B, which zero is contained in the confidence interval, this indicates there is no statistical difference between the two treatment levels. In this case, both inferences are “FALSE”.

VI.3. Result of Parameters Analysis

VI.3.1 Population Size

VI.3.1.1 Two Decision Variables Case

Five different population sizes were tested at crossover rate = 0.9 and mutation rate = 0.01. 10 runs with different random number sequence were run at each population setting. Fig. 12 is a comparison chart among different population sizes. In the chart, each dot represents the average of the genetic algorithm solution across the 10 replication runs for a given generation.

Table 10. Two decision variable case best solution found at generation 100 with different population size

	Population size				
	5	10	20	50	100
Average best solution	1165.1	1160.2	1158.5	1157.9	1157.8
Generation number where best occurs	89	97	87	64	87
% off optimum	0.64%	0.22%	0.07%	0.02%	0.01%

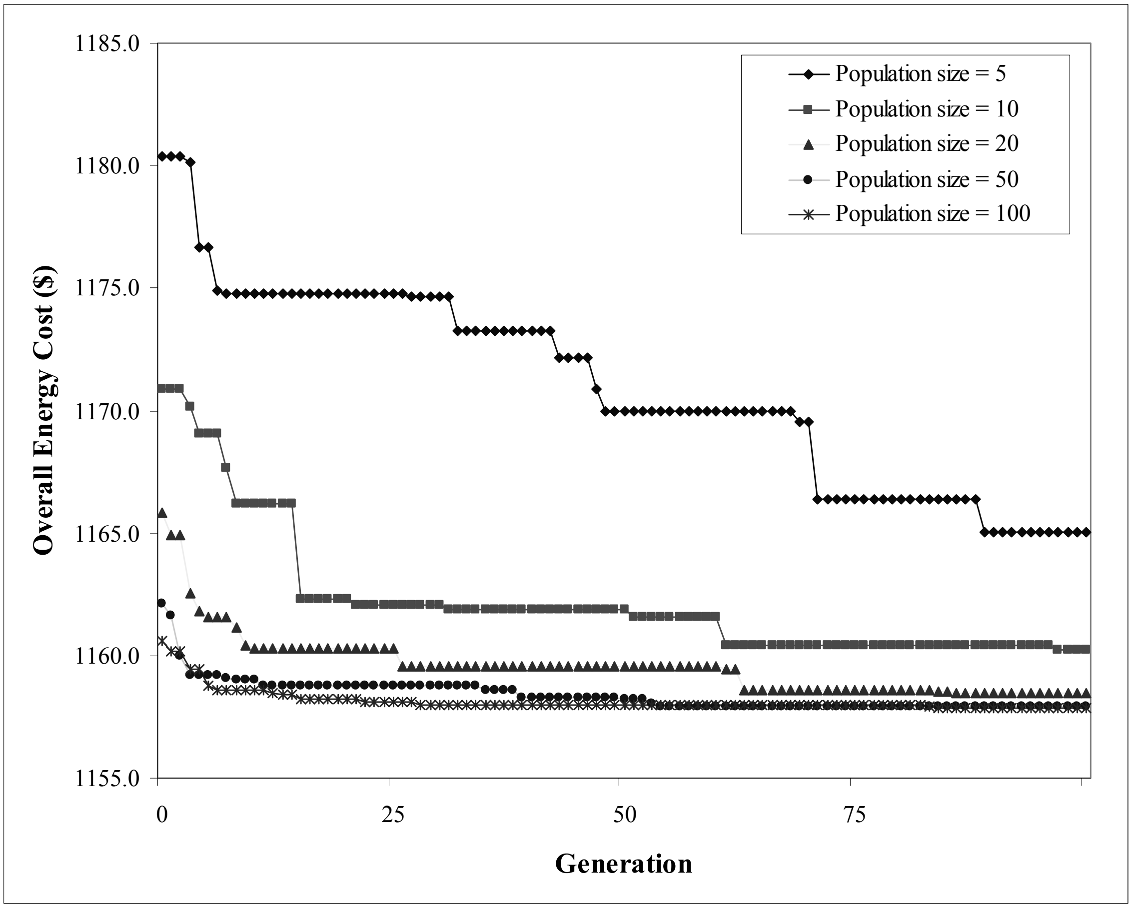

Fig. 12. Two decision variables case trend lines of average genetic algorithm solution across different population sizes

Since genetic algorithms starts with a population of randomly generated initial solutions, initial best solution in the population is always better for population with larger size than smaller ones, and this property is reflected in the figure. Fig. 12 also shows a better convergence trend for larger population sizes, and this is also demonstrated in Table 10, which shows the comparison of average genetic algorithm solutions found at the 100th generation for different population sizes. Another property revealed in Fig. 12 is that benefits with larger population size diminishes as population size gets larger.

Above conclusion was based on the convergence trend comparisons among average genetic algorithm solutions, statistical analysis was necessary to verify the conclusion.

First, a one-way ANOVA was conducted with null hypothesis that true genetic algorithm solution of a given generation was the same regardless of different population sizes. Note the one-way ANOVA test was conducted for each generation, which mean there were 100 ANOVA tests conducted.

Table 19 in APPENDIX C contains the results of the ANOVA tests. They show that null hypotheses are rejected for all generations, which indicates different population size settings do affect genetic algorithm performance.

Next, Hsu's procedure is used to identify the best population size and the test result is shown in Table 25 through Table 29 in APPENDIX D. Data in Table 25 indicates with 95% confidence, population size of 5 is not the best, while results in Table 26 to Table 29 have rejected both the first inference "the population size is not the best" and the second inference that "the population size is the best". Those results indicate that there are more than one genetic algorithm population settings are performing better than the rest. Therefore, according to results of Hsu's procedure, any population size of 10 and above is good population size.

When evaluating a non-deterministic optimization heuristic, the evaluation should not only focus on its average performance, but also the consistency of the performance as well. Even if a heuristic can perform well on average, it's still not a good one if its results have big variances across different runs since there will be much less confidence in the quality of the result for a given run. Fig. 13, Fig. 14, Fig. 15, Fig. 16 and Fig. 17 have revealed a very clear trend of reducing confidence interval of the genetic algorithm solutions across the first 100 generations. For each population size, we can see a trend in reducing variance in genetic algorithm solution found in population as generation progresses. The more meaningful comparison is to compare the confidence intervals of genetic algorithm solution across different population sizes. Table 11 offers a comparison of 95% confidence intervals on genetic algorithm solutions across all population sizes at the 100th generation. For population size = 5, although the average genetic algorithm solution in population is 0.697% above the optimum solution of 1157, the confidence interval's upper bound can be as much as 1% off in the worst case and 0.365% off in best case, which is nearly a 0.7% variation. However, for population size = 100, this variation is under 0.003%. Therefore, a bigger population size offers not only a better solution, but also solutions with more consistency and predictability.

Table 11. Two decision variables case 95% confidence intervals for genetic algorithm solutions at generation 100

	Population Size				
	5	10	20	50	100
Upper Bound	1168.9	1161.3	1158.8	1158.0	1157.9
Average	1165.1	1160.2	1158.5	1158.0	1157.8
Lower Bound	1161.2	1159.2	1158.1	1157.8	1157.8
Upper Bound % off Optimal	1.028%	0.373%	0.156%	0.089%	0.074%
Average % off Optimal	0.697%	0.280%	0.126%	0.080%	0.073%
Lower Bound % off Optimal	0.365%	0.187%	0.096%	0.072%	0.071%

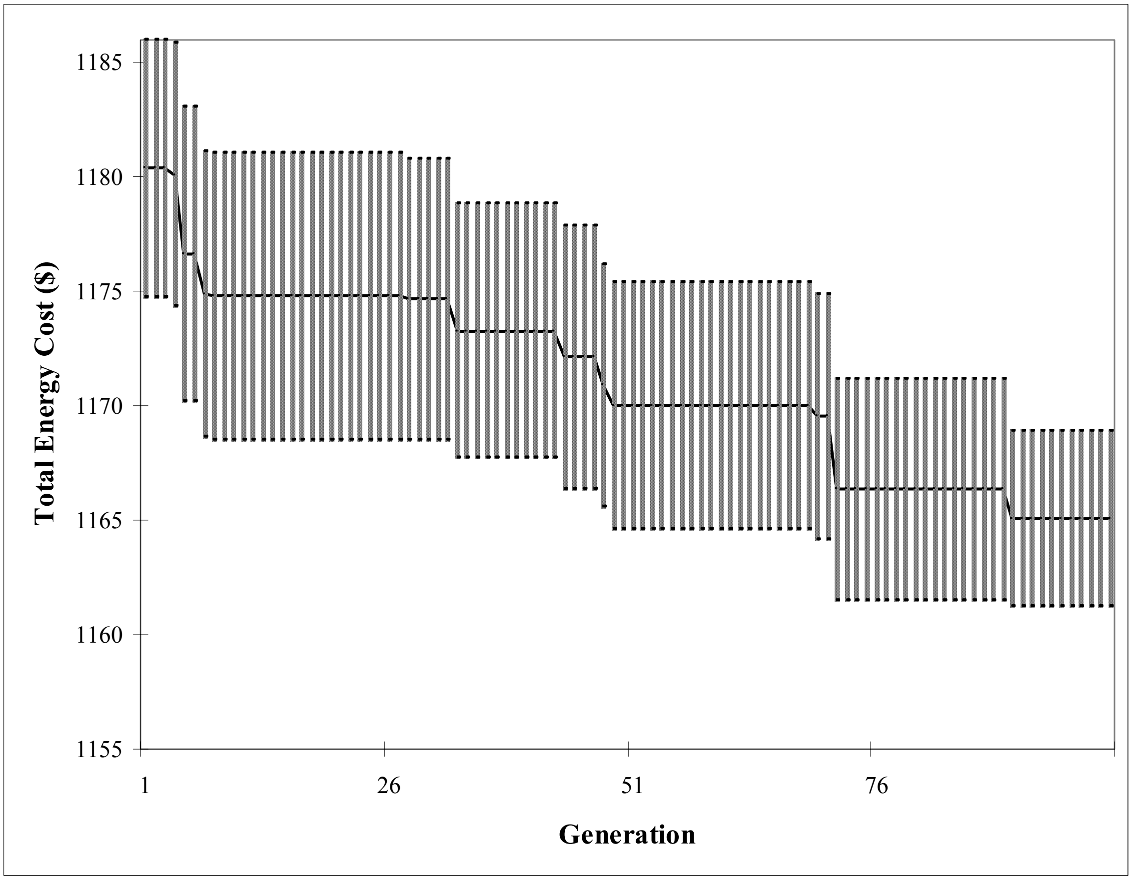

Fig. 13. Two decision variables case 95% confidence intervals for genetic algorithm solution with population size P = 5

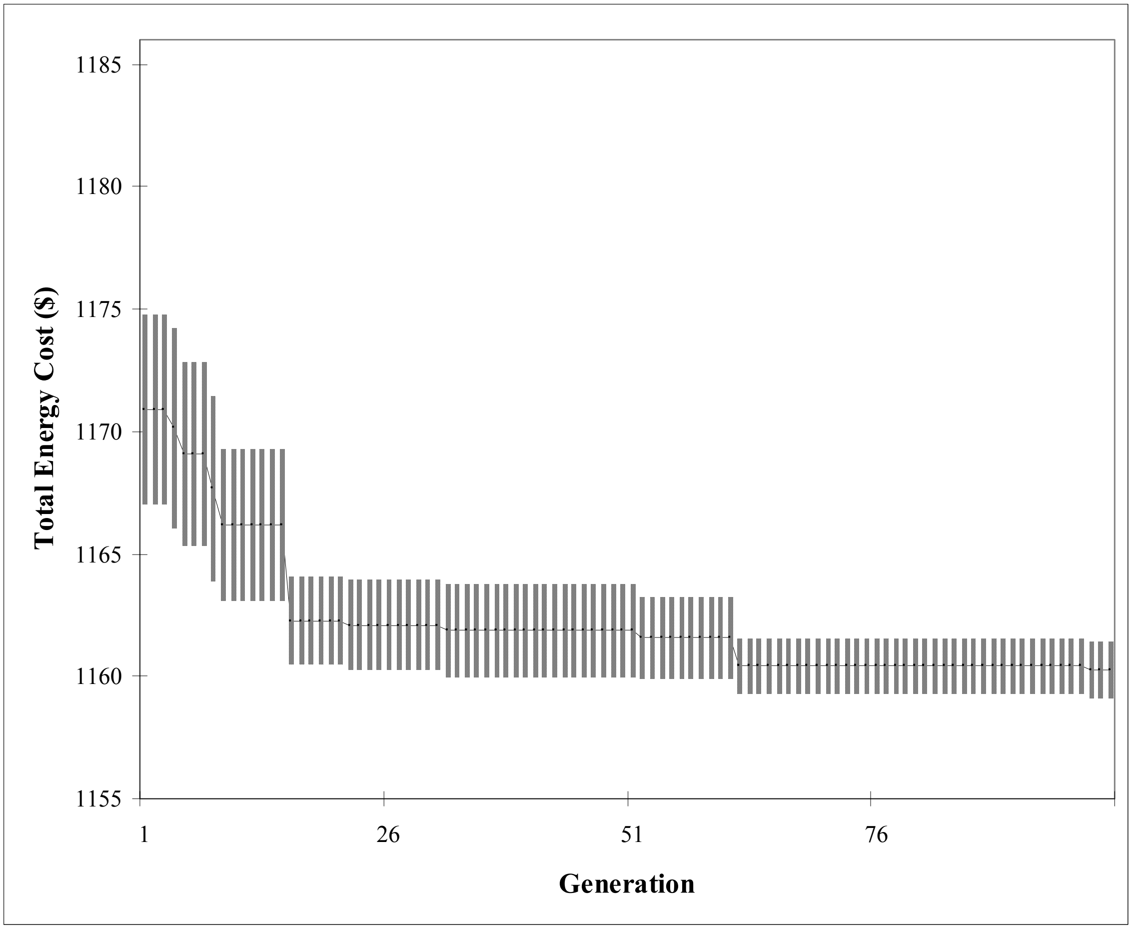

Fig. 14. Two decision variables case 95% confidence intervals for genetic algorithm solutions with population size P = 10

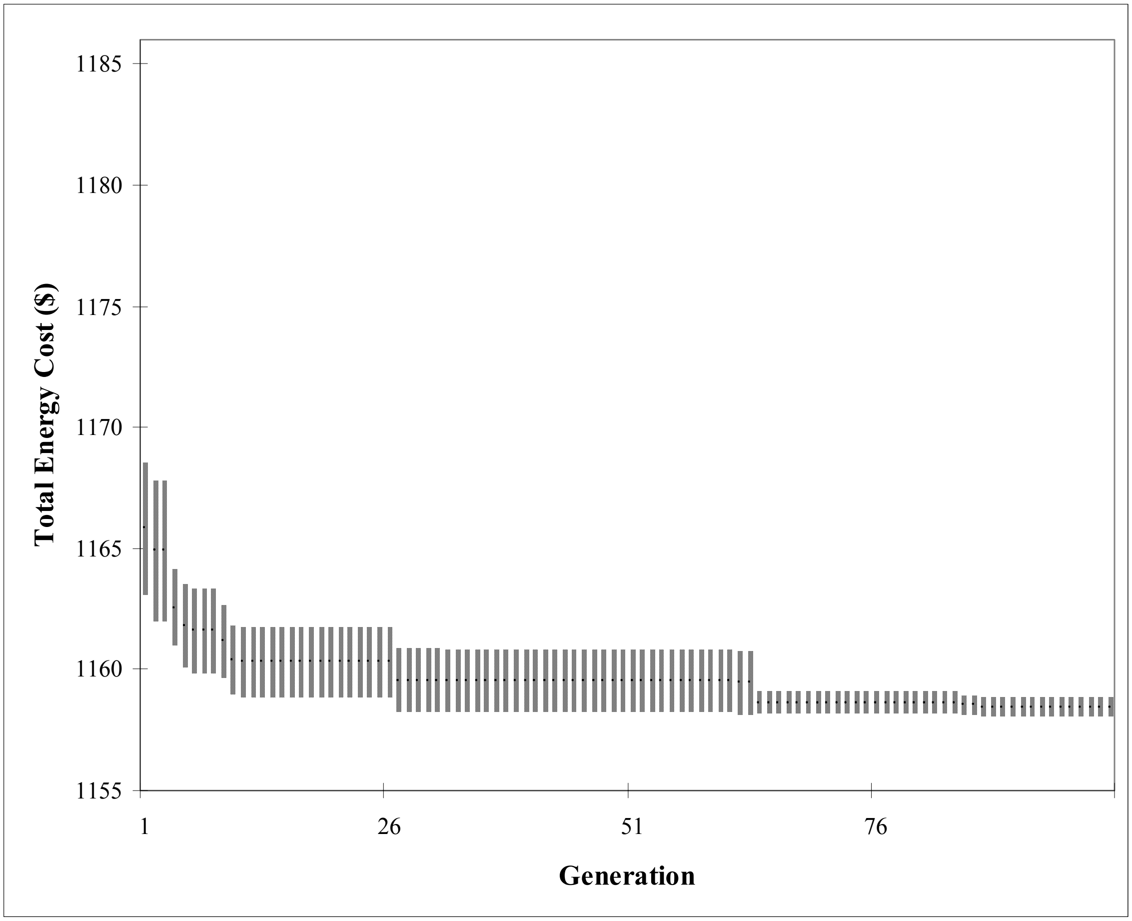

Fig. 15. Two decision variables case 95% confidence intervals for genetic algorithm solutions with population size P = 20

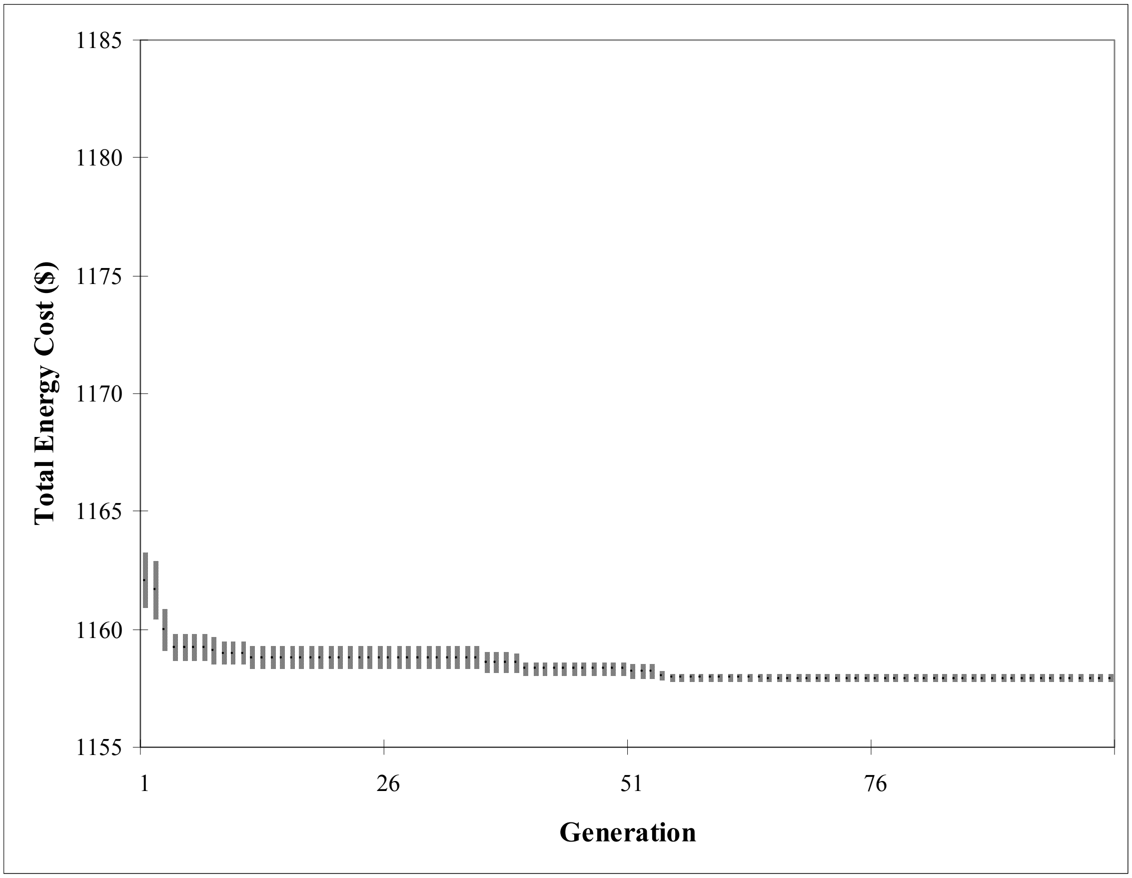

Fig. 16. Two decision variables case 95% confidence intervals for genetic algorithm solutions with population size P = 50

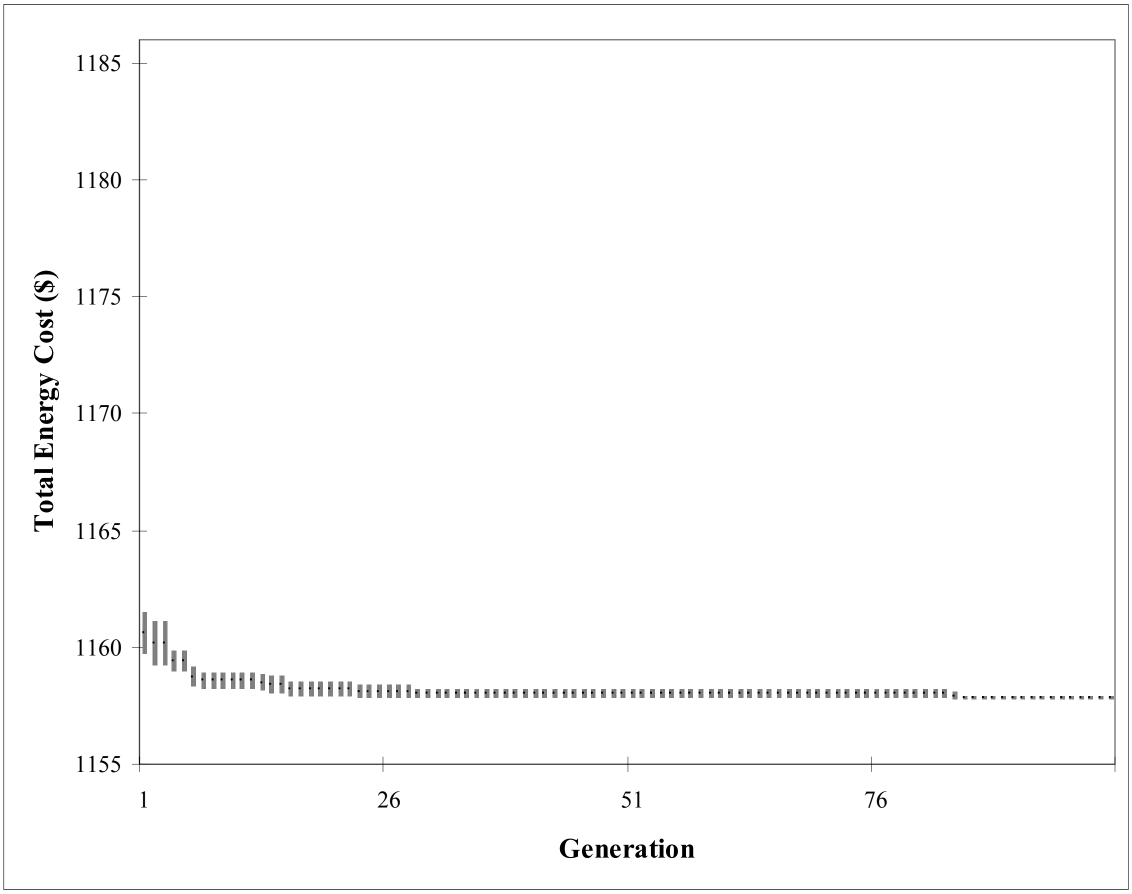

Fig. 17. Two decision variables case 95% confidence intervals for genetic algorithm solutions with population size P = 100

VI.3.1.2 Six Decision Variables Case

Fig. 18 is an average genetic algorithm solution convergence comparison among 5 different population size settings. It displays a similar pattern as in two decision variables case, with a better convergence speed towards a global minimum for a bigger population size. The trend also shows the improvements in convergence speed diminishes for bigger population sizes, especially at higher generation numbers.

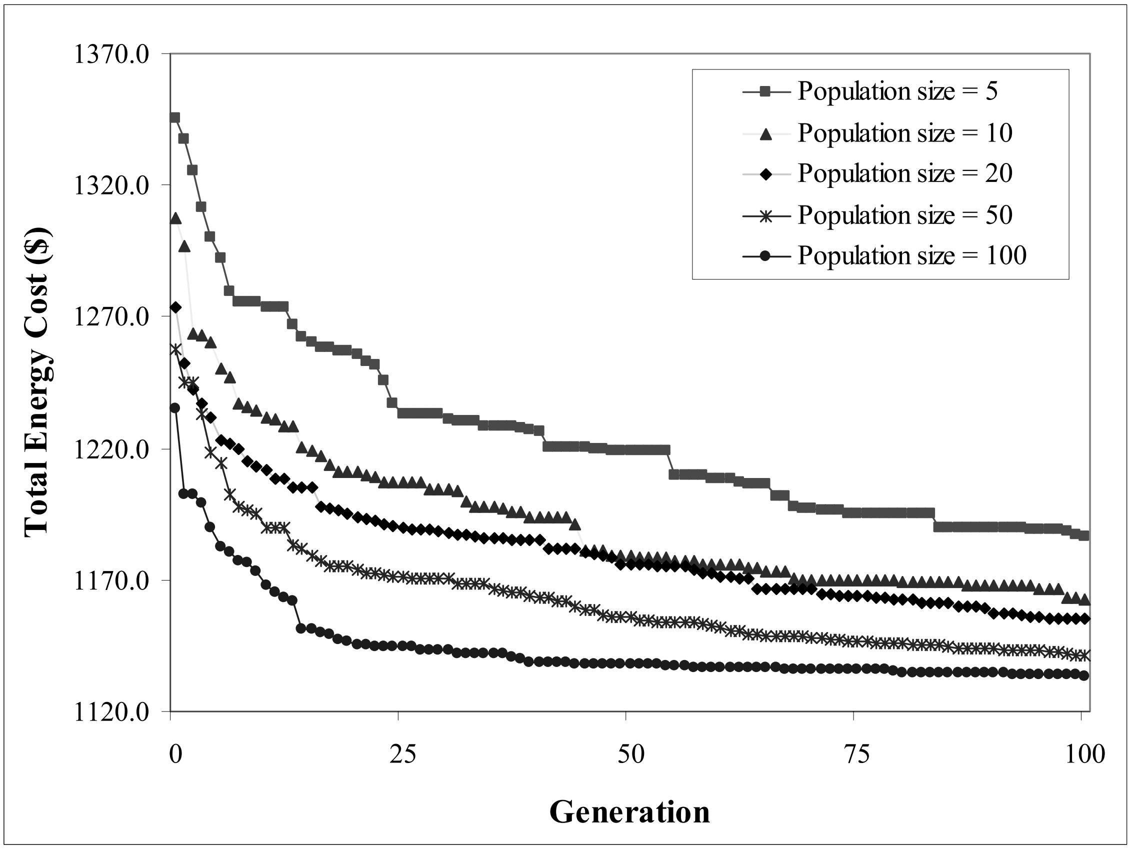

Fig. 18. Six decision variables case trend lines of average genetic algorithm solution with different population sizes

To test the significance of population size on the genetic algorithm's performance, again one-way ANOVA test was applied and the results are summarized in Table 20 of APPENDIX C. Once again the null hypothesis was rejected which means population size does affect genetic algorithm's performance. Results of Hsu's procedure are presented in Table 29 through Table 33 of APPENDIX D. Data from those tables tells a somewhat different story from the two decision variables case. First of all population sizes of 5, 10, and 20 were rejected as candidate for the best population size. The explanation for this is genetic operators (crossover and mutation) help genetic algorithms to converge faster under bigger population sizes, and this is more apparent for problems with higher dimensions (more decision variables). When it comes to identifying the best population size setting, inferences from Hsu's procedure result still rejects either population size = 50 or population size = 100 as the best performer. This indicates the genetic algorithm performance differences under these two population sizes are not statistically different, therefore both population sizes can be treated as optimum population size.

In the next step, between the two identified population sizes, confidence intervals on the genetic algorithm solution were compared in an attempt to identify whether one was better than the other in terms of variance. Fig. 19 and Fig. 20 are the confidence intervals for genetic algorithm solutions for the first 100 generation for both population size settings. Both show a reducing confidence interval as generation becomes larger, and it seems there isn't much difference in confidence interval between the two settings at the same generation. To further identify a "snapshot" at generation 100 was taken and relevant data was put in Table 12. For the purpose of comparison, genetic algorithm solution confidence intervals for population size = 5, 10, 20 are also included.

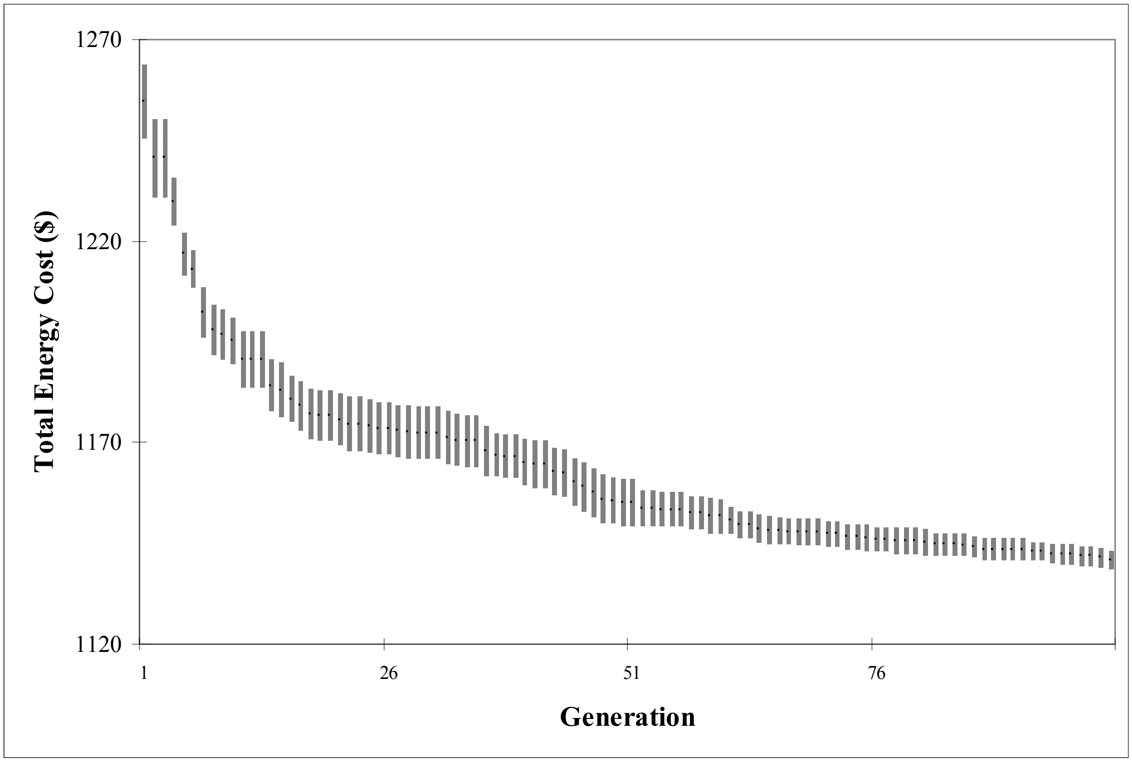

Fig. 19. Six decision variables case 95% confidence intervals for genetic algorithm solutions with population size P = 50

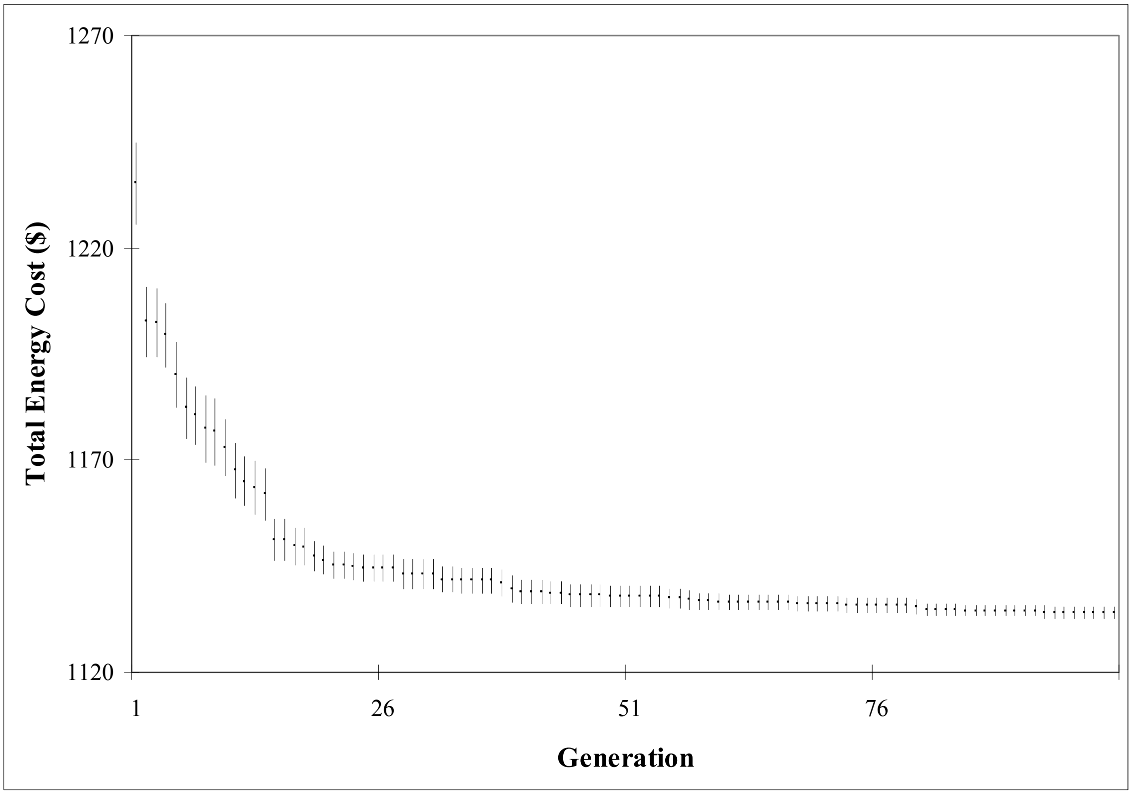

Fig. 20. Six decision variables case 95% confidence intervals for genetic algorithm solutions with population size P = 100

Following observations were made from the data in Table 12: For smaller population sizes (population size of 20 and under), increasing population size reduces confidence interval drastically, with a general trend that doubling the population size can result in halving the confidence interval. As population size becomes larger, the reduction in confidence interval attenuates, as doubling population size from 50 to 100 only results in a 25% decrease in confidence interval.

With above information, a similar conclusion can be drawn about the effect of population size on genetic algorithm's performance: genetic algorithm favors a larger population size. However, the benefit of having a larger population size diminishes as the population size become larger. At the same time, the computational burden grows in right proportion to population size. For the case study here, a population size of 50 was sufficient.

Table 12. Six decision variables case 95% confidence interval comparison for genetic algorithm solution with different population sizes at generation 100

	Population Size				
	5	10	20	50	100
Upper Bound	1203.78	1172.16	1160.24	1142.61	1135.37
Average	1187.28	1162.93	1155.40	1140.83	1134.00
Lower Bound	1170.78	1153.70	1150.56	1139.05	1132.63
95% Confidence Interval Width	32.99	18.47	9.68	3.56	2.75
Upper Bound % off Optimal	7.48%	4.66%	3.59%	2.02%	1.37%
Average % off Optimal	6.01%	3.83%	3.16%	1.86%	1.25%
Lower Bound % off Optimal	4.53%	3.01%	2.73%	1.70%	1.13%

VI.3.1.3 Another Look at Population Sizes Analysis

ANOVA's fundamental assumptions are: (1) normality, (2) equal variance, and (3) independence. As the genetic algorithm solution is selected from a population of solutions, equal variance is violated if the population sizes are different. Is ANOVA still applicable? Neter, *et al.* (1996) has summarized the effects of departure from those assumptions. According to Neter, *et al.*, unequal variance only slightly affects ANOVA model provided sample sizes are equal for all treatment levels. In order to gain more confidence on the test result, one other statistical test procedure is selected to study the behavior of population size on the genetic algorithm's performance.

Kruskal-Wallis test is used to test the equality of treatment means for test data with unequal variance. It is also used to test the equality of treatment means. Below is a description of the application of the test:

Define

R_{ikl} Rank of treatment level k, replication i in generation l.

$\overline{R}_{\cdot\cdot l}$ Average rank in generation l

$\overline{R}_{\cdot kl}$ Average rank for treatment level k in generation l

Sum of square of the treatment levels $SS^l_{treatment}$ is:

$$SS^l_{treatment} = R\sum_{k=1}^{K}(\overline{R}_{\cdot kl} - \overline{R}_{\cdot\cdot l})^2 \qquad (29)$$

Total sum of square SS^l_{total} is:

$$SS^l_{total} = \sum_{k=1}^{K}\sum_{i=1}^{R} (\overline{R}_{ikl} - \overline{R}_{\cdot\cdot l})^2 \qquad (30)$$

The Kruskal-Wallis test statistic $X^2_{KW(l)}$ is:

$$X^2_{KW(l)} = \frac{SS^l_{treatment}}{\dfrac{SS^l_{total}}{KR-1}} \qquad (31)$$

Using the same hypothesis as in ANOVA, conclusions can be made based upon following criteria:

Accept H_0 if $X^2_{KW(l)} \leq \chi^2(1-\alpha, R-1)$

Reject H_0 otherwise.

According to Neter, *et al.*, if the null hypothesis is rejected, a multiple pairwise testing procedure can applied to identify which treatment level(s) is the best. In order to identify the best treatment level, the test procedure iterates through all the possible pairs of treatment means. Therefore, for treatment with K levels, the total number of pair wise tests g is:

$$g = \frac{K(K-1)}{2} \tag{32 }$$

And the test limit of the comparison between level k and $k^{'}$ is:

$$(\overline{R}_{\cdot kl} - \overline{R}_{\cdot k'l}) \pm B\left[\frac{K(RK+1)}{6}\right]^{\frac{1}{2}} \tag{33 }$$

Where:

$$B = z(1-\frac{\alpha}{2g}) \tag{34 }$$

If test limits include zero, and it indicates the two treatment level means are not different. Otherwise the two treatment level means are different. For the problem under study, there were 5 treatments, and it needed 10 pair wise comparisons to find the best population size setting.

Table 51 and Table 52 are the results of Kruskal-Wallis test for both cases. Same as ANOVA test, all null hypotheses were rejected. Results of the further pair wise comparison can be found in Table 53 and Table 54, and those results are summarized in Table 13 and Table 14. Data in both tables also demonstrate a trend of the need for a bigger population size. It also reveals that an increasing population size results in better performance. Furthermore, it also shows that there is statistically no performance difference between neighboring population sizes (e.g. between population sizes of 5 and 10, 20 and 50, 50 and 100), and this implies that it takes more than doubling the population size to see a significantly improved performance.

Table 13. Summary of pair wise comparison, two decision variables case

	Population Size				
Population Size	5	10	20	50	100
5	N/A	Not Significant	Not Significant	Significant	Significant
10	Not Significant	N/A	Not Significant	Significant	Significant
20	Not Significant	Not Significant	N/A	Not Significant	Not Significant
50	Significant	Significant	Not Significant	N/A	Not Significant
100	Significant	Significant	Not Significant	Not Significant	N/A

Table 14. Summary of pair wise comparison, six decision variables case

	Population Size				
Population Size	5	10	20	50	100
5	N/A	Not Significant	Significant	Significant	Significant

10	Not Significant	N/A	Not Significant	Not Significant	Significant
20	Significant	Not Significant	N/A	Not Significant	Significant
50	Significant	Not Significant	Not Significant	N/A	Not Significant
100	Significant	Significant	Significant	Not Significant	N/A

VI.3.2 Crossover Rate

In this section, based on a population size of 50 and crossover rate of 0.01, four different settings of crossover rate settings: 0.3, 0.5, 0.7, and 0.9, were tested, with 10 replications for each setting.

VI.3.2.1 Two Decision Variables Case

Data from the first 100 generation was picked for analysis, and the average genetic algorithm solution convergence trend for all crossover rates is shown in Fig. 21. Unlike the case for population sizes, there are more crossing among different crossover rates, in fact the trend lines are so close to each other that no crossover rate setting can be identified as the best setting.

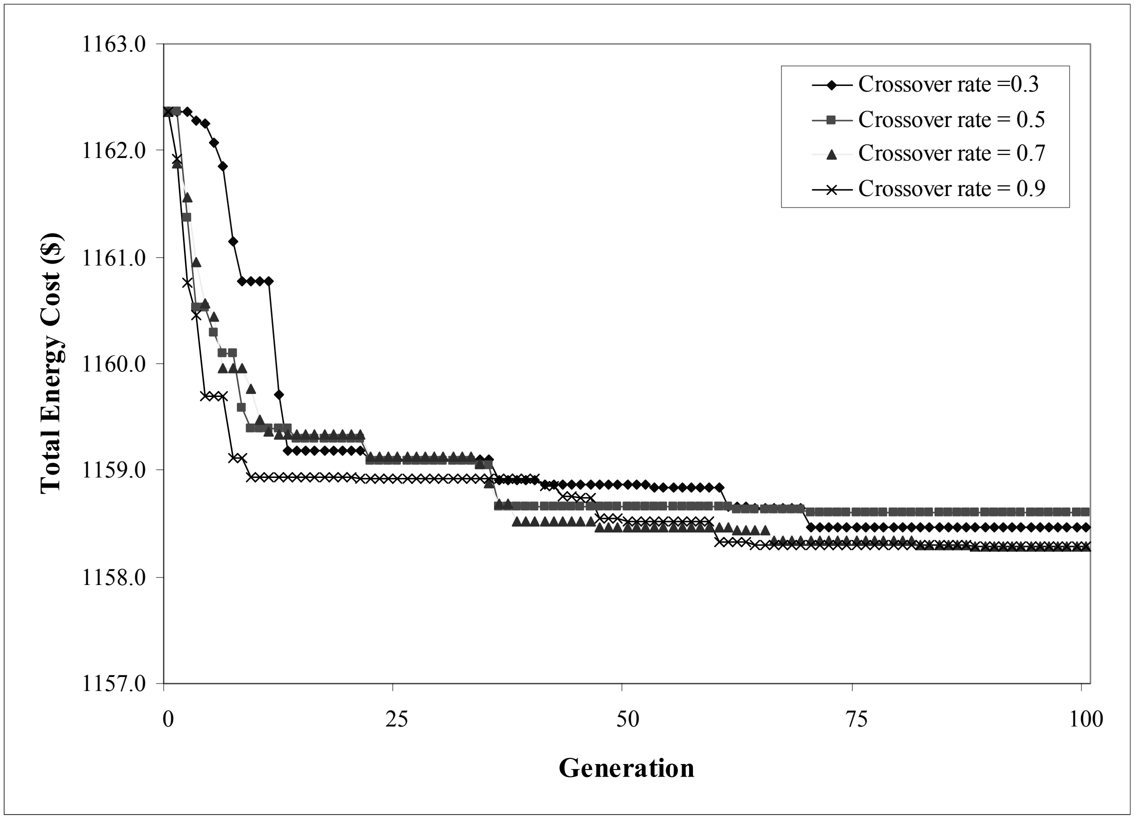

Fig. 21. Two decision variables case trend lines of average genetic algorithm solution with different crossover rate

In order to test if there was any crossover rate that was significantly better than others, ANOVA analysis is conducted and the test results are presented in Table 21 of APPENDIX C. Analysis result shows the null hypothesis was accepted across all generations, which indicates different crossover rates really doesn't affect the algorithm's performance.

VI.3.2.2 Six Decision Variables Case

Statistical analysis on two decision variables case reached the conclusion that crossover rates are insignificant to overall genetic algorithm performance, is it the same case for six decision variables case? Fig. 22 shows the trend line comparisons of average genetic algorithm solutions with different crossover rates. The trend lines are also clustered across the 200 generations. In order to test statistical significance among them, one-way ANOVA test was conducted and the results are presented in Table 22 of APPENDIX C.

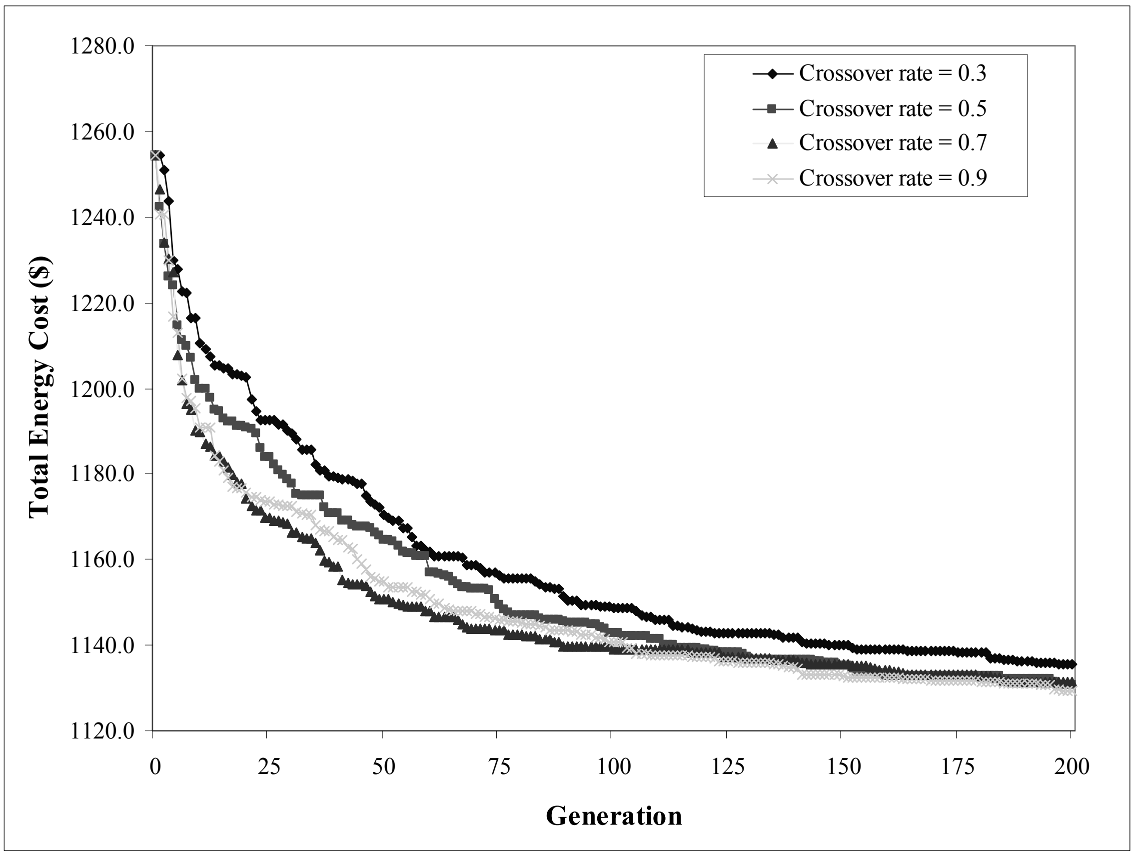

Fig. 22. Six decision variables case trend lines of genetic algorithm solutions with different crossover rate

In Table 22, the decisions on null hypothesis are no longer a straight "ACCEPT" as in two decision variables case. They are intervening between "ACCEPT" and "REJECT" in the first 100 generations. Starting from generation 114, "ACCEPT" decisions begin to dominate. All of these imply crossover rates do have significant impact on the algorithm's performance in the early stage of the optimization process and this impact fades away as the algorithm advances towards global optimum. Trend lines in Fig. 22 also support this conclusion as at least three of the trend lines merge together after generation 110, with the fourth one, which belongs to crossover rate = 0.3, although lagging behind, also coming closer to the rest three.

Hsu's procedure was applied in an attempt to identify the best crossover rate for the algorithm. Table 34 through Table 37 of APPENDIX D show the result of Hsu's procedure. In Table 34, crossover rate = 0.3 was found to be not the best across most of the generations, especially for the first 160 generations. Even for crossover rate = 0.5 (Table 35), there were still quite a few generations in the first 100 generations that were rejected as the candidate as the best crossover rate. The distinction between crossover rate = 0.7 and 0.9 is not apparent at all, with both to be neither not the best nor the best across all generations, which means either one can be used as a preferable crossover rate setting.

VI.3.3 Mutation Rate

Study on mutation rate is conducted in a similar way as for crossover rate. In both the two decision variables and the six decision variables case, the settings were: population size = 50, crossover rate = 0.9, mutation rate settings of 0.01, 0.05, 0.07, and 0.10 were tested with 10 replications for each setting.

VI.3.3.1 Two Decision Variables Case

Trend comparison among different mutation settings is graphically presented in Fig. 23. The figure doesn't show a "the-higher-the-better" value settings as of two previous parameters. Higher mutation rate results in faster convergence in the first 40 generations, however afterwards convergence speed for mutation rate = 0.10 slow down and it is superseded by both mutation rate = 0.05 and 0.07. a possible explanation of this is, during initial stage of the search, higher mutation rate helps the algorithm to explore new solution space and locate the region which leads to global optimum faster; but, in the latter stage, it is more likely to destroy the good quality genes and hence disrupt the optimization convergence progress. To justify the finding, statistical analysis is conducted and results are presented as follows:

Table 23 of APPENDIX C contains the results of one-way ANOVA tests one the different mutation rate settings. It can be seen from the data that as generation proceeds, the ANOVA decision starts from accepting the null hypothesis and gradually switching to rejecting it. This indicates different mutation rates don't have impact on genetic algorithm's performance in the early stage, but by and by, at least one or some mutation rate setting(s) outperforms the others towards the latter stage. To identify which is(are) those mutation setting(s), more statistical analysis is conducted using Hsu's procedure and the result is presented in Table 42 through Table 45 of APPENDIX D. From the data in table it shows that (1) mutation rate = 0.01 is the worst performer, and (2) other mutation rate settings all yield better results; however there is statistically no difference in performance among those mutation rate settings.

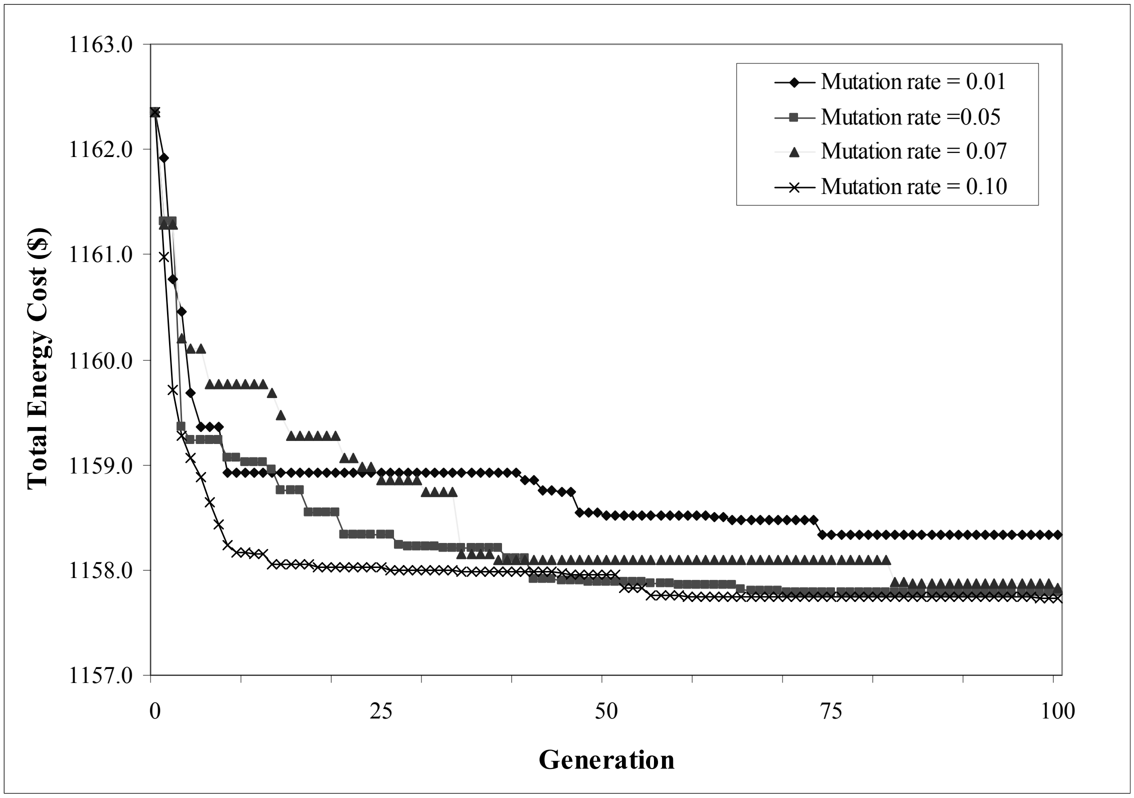

Fig. 23. Two decision variables case trend lines of average genetic algorithm solutions with different mutation rate

VI.3.3.2 Six Decision Variables Case

The same mutation rate settings: 0.01, 0.05, 0.07, and 0.10 were tested for the six decision variables case and the trend chart is shown in Fig. 24. The same criss-cross pattern is showing again as in the two decision variables case. In order to test statistical significance, one-way ANOVA analysis is conducted and results are presented in Table 24 of APPENDIX C. Test results are pretty consistent with what can be observed from Fig. 24: the null hypothesis are being accepted in the first 20 generations, then rejections come in and finally become dominant from 52nd generation. In order to tell which mutation rate gives the best result, Hsu's test was applied and the results are presented in Table 46 through Table 49 of APPENDIX D. Data in tables reinforces the previous finding; furthermore, all other mutation rates were rejected as the candidate of the best mutation rate, and Hsu's procedure identifies mutation rate = 0.05 as the best performer.

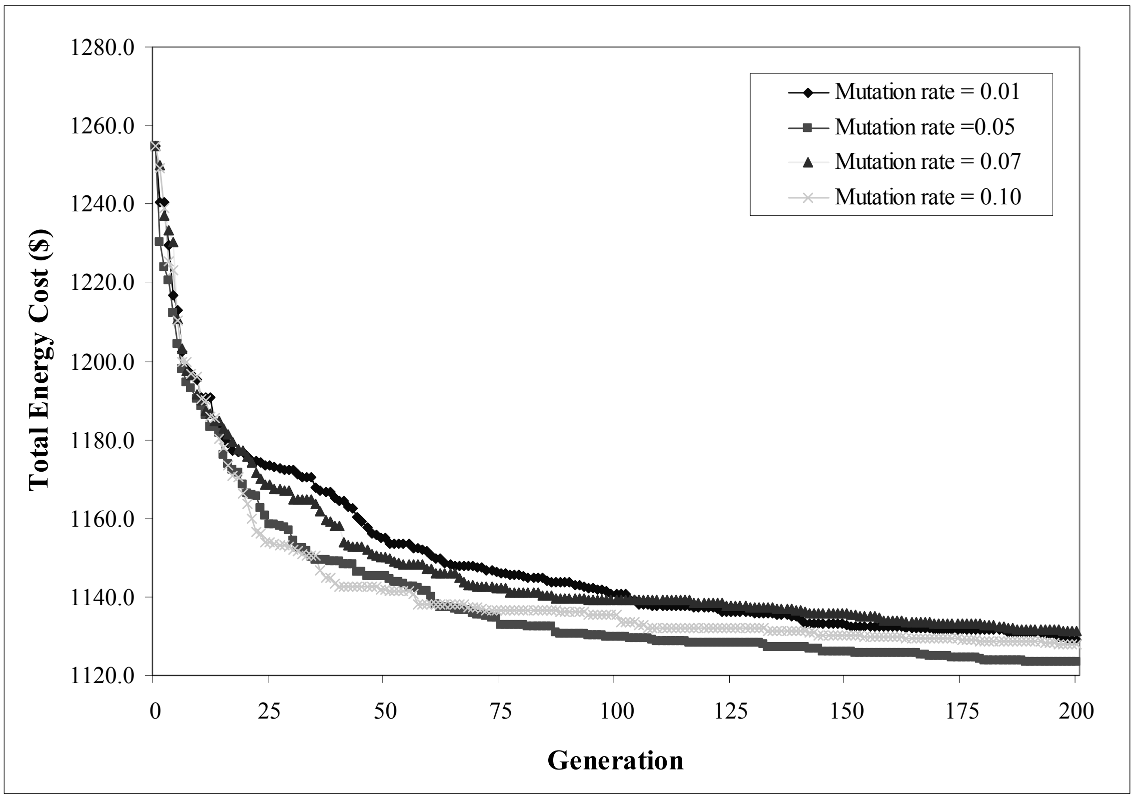

Fig. 24. Six decision variables case trend lines of average genetic algorithm solutions with different mutation rate

VI.4. Statistical Analysis Summary

As a brief summary on the analyses on the two cases, the following conclusions on the preferred population size, crossover rate, and mutation rate are summarized as follows:

For two parameter case, the population size can be as small as around 10 to achieve satisfactory overall performance; however, in order to achieve more consistent results, a population size of 30 or higher is recommended. Crossover rate appears to be an unimportant factor for this case. Compared with crossover rate, the genetic algorithm is more sensitive to mutation rate. Although the statistical procedure cannot identify which mutation rate is the best, mutation rate = 0.01 was identified as the worst.

For the six parameter case, larger population sizes were preferred. Crossover rate seems to be an unimportant factor for both the two parameter and the six parameter cases; however, although not backed by statistical analysis results, there was a tendency in the six parameter case that higher crossover rates preferable. Performance against different mutation rate settings are most clean cut in this case. Both visual observation and statistical procedure identified 0.05 to be the best mutation rate.

Based on above analysis, the following parameters settings were selected for the genetic algorithm: population size = 50, crossover rate = 0.9, mutation rate = 0.05. Results of the test runs with this setting is displayed in Table 15. For comparison purpose, Table 15 also includes test results under other randomly picked neighboring parameter settings.

It was clear that the selected parameter setting outperformed the rest. At the end (200^{th} generation) of genetic algorithm run, it had achieved the final energy cost of $1,123.40 on average of the 10 replications, which is only 0.268% above the global minimum.

Table 15. Results comparisons among different six decision variables case parameter settings

Parameter settings			Results			
			At 100th generation		At 200th generation	
Population	Crossover rate	Mutation rate	Energy cost	% off optimum	Energy cost	% off optimum
50	0.9	0.05	1129.6	0.86%	1123.4	0.30%
50	0.9	0.10	1135.3	1.37%	1127.9	0.71%
50	0.9	0.01	1141.5	1.92%	1129.6	0.86%
50	0.7	0.05	1135.7	1.40%	1128.6	0.77%
100	0.9	0.05	1131.9	1.06%	N/A	N/A
100	0.9	0.10	1136.2	1.45%	N/A	N/A
100	0.7	0.10	1141.0	1.88%	N/A	N/A
100	0.7	0.05	1135.6	1.39%	N/A	N/A

VII. CONCLUSION

The purpose of the internship is to develop a general purpose parametric building energy cost optimization tool. In this record of study, various issues of the tool, ranging from genetic algorithm design and implementation, programming implementation are discussed. Finally the genetic algorithm's parameters are analyzed statistically with their recommended range of also identified. The case studies show the genetic algorithm used in the case has achieved very good results in the problem under study.

VII.1. Future Work

Despite the good results, the tool is not perfect yet. In this section, some room for improvement, from both an algorithmic and an implementation aspects will be discussed.

First is the convergence issue. Just as pointed out in many literatures, a genetic algorithm is effective in jumping out of the local minimum and locating the area which leads to global optimum. However, it often has problem converging to global optimum, which has also be reflected in out case studies. Take the six decision variables case, in the experiment setting with crossover rate = 0.9, mutation rate = 0.05, population size = 50 and random number seed = 2, the fitness value of genetic algorithm solution at generation 0 was $1277.30, which was 14% off from the global optimum of $1,120; at generation 43, the genetic algorithm solution fitness was reduced down to $1,136.9, a mere 1.51% higher than the global optimum. However, after that, the algorithm progresses slowly, hunting around the neighborhood of the global optimum without hitting on it. By the time genetic algorithm stopped at the 200th generation, the fitness value of best solution was still 0.34% off global optimum. Table 16 summarizes some genetic algorithm solutions at some representative generations. It can be seen from the table that genetic algorithm already had reached the vicinity of the global optimal (with in 1%) starting from 68th generation but still failed to converge to the global optimum when the algorithm ended at generation 200.

To overcome this, one solution is to adjust the mutation strategy so that genetic algorithm mutation explores a closer vicinity of current solution in the later stage of the search. One example of such a mutation strategy is proposed by Michalewicz (1996), the details is as follows:

Table 16. An example of the genetic algorithm's convergence problem

			Window-to-Wall Area Percentage					
Gen.	A/C Cooling Efficiency (SEER)	Orientation	Front (%)	Back (%)	Left (%)	Right (%)	Fitness	*% off Optimal*
199	1	10	10	11	11	10	1123.8	*0.34%*
165	353	10	10	10	14	10	1126.6	*0.59%*
95	353	11	10	10	15	10	1128	*0.71%*
68	353	11	10	11	15	10	1130	*0.89%*
43	353	11	10	11	15	22	1136.9	*1.51%*
37	353	11	10	18	15	22	1151	*2.77%*
29	353	13	10	18	15	10	1153.6	*3.00%*
24	353	13	10	18	15	41	1168.2	*4.30%*
16	353	14	10	18	15	22	1168.6	*4.34%*
6	*23*	*14*	*10*	*14*	*15*	*54*	*1174.8*	*4.89%*

For a given parent solution $\vec{x} = (x_1,...,x_k,...,x_n)$, where x_k is the decision variable selected for mutation, then the offspring solution $\vec{x}^{'} = (x_1,...,x_k^{'},...,x_n)$ and $x_k^{'}$ is generated by selecting randomly from either of the following two cases:

$$x_k^{'} = x_k + \Delta(t, x_k^U - x_k) \tag{35}$$

$$x_k^{'} = x_k - \Delta(t, x_k - x_k^L) \tag{36}$$

where function $\Delta(t, y)$ returns a value between $[0, y]$ and it's monotone decreasing against t, which is the generation number. This functional structure forces mutation operator to give more search on the local neighborhood of current solution as generation grows. One example of the function $\Delta(t, y)$ given by Gen and Cheng (2000) is given as follows:

$$\Delta(t, y) = yr(1 - \frac{t}{T})^b \tag{37}$$

where

r is a random number between 0 and 1

T is the total generation number

b is the parameter determining degree of nonuniformity.

Another solution is, in the light of the fact that for many building optimization problem types, global optimum is likely to occur at decision variables' boundary point (This is also true for many other constrained optimization problem as well), therefore, mutation operators that can give more hit on the decision variable's boundaries can be designed and applied.

The third possible solution is to use hybrid genetic algorithms to improve the local search efficiency. Gen and Cheng (2000) offered a general structure of hybrid genetic algorithms, in which a hill-climbing heuristic is plugged after crossover and mutation and before selection process so as to let the newly generated genes to adapt and develop themselves before competing to enter the next generation. Moscato and Norman (1992) has named this hybrid algorithm as memetic algorithm. Such application of hybrid genetic algorithms also achieved good result in real world applications. Both Huang *et al.* (2000) and Yu *et al.* (2000), although used slightly different approach in their applications, have applied combined simulated annealing with genetic algorithms in their applications and have achieved better results with less computational effort. Lin, *et al.* (1993) also had similar applications in their work.

Apart from the improvement that can be made on the algorithm side, genetic algorithm's implementation is another area for improvements. Despite the good results eCalc-Op has achieved, it is still very computationally intensive. eCalc-Op needs to do from 4,000 to 10,000 iterations for a typical optimization run in our two case studies, and this means 2-5 hours of computational time on a latest Pentium IV 3GHz computer. Out of this lengthy computational time, nearly 100% is incurred in the objective function evaluation, namely DOE-2 simulation. One way to improve the situation is to implement parallel computation. As mentioned before, genetic algorithm inherently processes its population of solutions in parallel; furthermore, eCalc's architecture also facilitates parallel processing by adding more calculation servers. However, eCalc-GA does not support parallel computation due to the limitation in GALib (Wall, 2005). Therefore, modifying GALib's source code to facilitate parallel implementation is another way to improve eCalc-Op's performance.

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APPENDIX A

Table 17. eCalc-Op decision variable list for single family and multifamily residential building

Decision Variable Name	eCalc Parameter Name	Min	Max	Unit	Description
Azimuth of building (degree)	b03	0	360	degree	0: South, 90: West, 180: North, 270: East, 360: South
Width of building	b04	30	200	ft	The width of the building when facing the main entrance of the building
Depth of building	b05	30	200	ft	
Height of wall	b06	6.67	40	ft	
Height of crawl space wall above ground	b12	0.01	4	ft	
Height of crawl space wall under ground	b13	0.01	4	ft	
Roof R-value	c04	0.05	99	Hr-ft^2-F/Btu	
Wall R-value	c08	0.05	99	Hr-ft^2-F/Btu	
U-Factor of glazing	c11	0.25	4	Btu/hr-ft^2-F	
Solar Heat Gain Coefficient	c12	0.1	0.87	SHGC	
Front window-to-wall percentage	c21	1	80	%	Percentage of window area (%) for front side wall
Back window-to-wall percentage	c22	1	80	%	Percentage of window area (%) for back side wall
Right window-to-wall percentage	c23	1	80	%	Percentage of window area (%) for right side wall

Table 17. (Continued)

Decision Variable Name	eCalc Parameter Name	Min	Max	Unit	Description
Left window-to-wall percentage	c24	1	80	%	Percentage of window area (%) for left side wall
Floor R-Value	c26	0.05	99	hr-ft^2-F/Btu	
Front eave shade (ft)	s01	0	40	Ft	Front eave shade (ft)
Back eave shade (ft)	s02	0	40	Ft	Back eave shade (ft)
Left eave shade (ft)	s03	0	40	Ft	Left eave shade (ft)
Right eave shade (ft)	s04	0	40	Ft	Right eave shade (ft)
A/C Cooling Efficiency	sy04	8.00	20.00	SEER	SEER = Seasonal Energy Efficiency Ratio
Furnace Heating Efficiency	sy05	0.60	1.00	AFUE	AFUE = Annual Fuel Utilization Efficiency
A/C Heating Efficiency	sy06	5.00	12.00	HSPF	HSPF = Heating Seasonal Performance Factor
Domestic Hot Water Efficiency	sy11	1.00	100.00	%	
Air Exchange*					

*Note: This parameter will be available in the next version of eCalc.

Table 18. eCalc-Op decision variable list for office building

Decision Variable Name	eCalc Parameter Name	Min	Max	Unit	Description
Azimuth of building (degree)	b03	0	360	degree	0: South, 90: West, 180: North, 270: East, 360: South
Width of building	b04	31	1000	Ft	The width of the building when facing the main entrance of the building
Depth of building	b05	31	1000	Ft	
Floor to floor height	b10	8	32	Ft	
Roof R-value	c04	0.05	99	Hr-ft^2-F/Btu	
Wall R-value	c08	0.05	99	Hr-ft^2-F/Btu	
U-Factor of glazing	c11	0.25	2	Btu/hr-ft^2-F	
Solar Heat Gain Coefficient	c12	0	0.87	SHGC	
Front window-to-wall percentage	c21	0	70	%	Percentage of window area (%) for front side wall
Back window-to-wall percentage	c22	0	70	%	Percentage of window area (%) for back side wall
Right window-to-wall percentage	c23	0	70	%	Percentage of window area (%) for right side wall
Left window-to-wall percentage	c24	0	70	%	Percentage of window area (%) for left side wall

Table 18. (Continued)

Decision Variable Name	eCalc Parameter Name	Min	Max	Unit	Description
Interior wall insulation (R-value)	c26	0.05	99	hr-ft^2-F/Btu	
Front eave shade (ft)	s01	0	10	Ft	Front eave shade (ft)
Left eave shade (ft)	s03	0	10	Ft	Left eave shade (ft)
Right eave shade (ft)	s04	0	10	Ft	Right eave shade (ft)
A/C Cooling Efficiency	sy04	8.00	20.00	SEER	SEER = Seasonal Energy Efficiency Ratio
Furnace Heating Efficiency	sy05	0.60	1.00	AFUE	AFUE = Annual Fuel Utilization Efficiency
A/C Heating Efficiency	sy06	5.00	12.00	HSPF	HSPF = Heating Seasonal Performance Factor
Domestic Hot Water Efficiency	sy11	1.00	100.00	%	
Fan Control*					
Outside Air Fraction*					
Supply Air Pressure	sy18	0	6	W.G.	
Chiller Efficiency*					
Boiler Efficiency	p15	50	100	%	

*Note: This parameter is not available in current version of eCalc.

APPENDIX B

```
<?xml version="1.0" encoding="utf-8" ?>
<configuration>
        <configSections>
                ……
        </configSections>
<appSettings>
                <add key="ConfigSectionName" value="HOME" />
                <add key="SectionNames" value="COMMON, XML" />
</appSettings>

<HOME>
        <COMMON>
                <add key="Scenario" value="SNGFAM2ST"/>
                <add key="ConnectionString" value="User
ID=e2calc_DEV;Password=*****;Initial Catalog=eCalc_DEV_v12;Data Source=localhost"/>
                <add key="ModelProjectXMLPath"
value="D:\GA_Data\Project_Source\ProjectTemplate.xml"/>
                <add key="PollInterval" value="1000"/>
                <add key="XMLProjPath" value="R:\XML\Project" />
                <add key="XMLJobPath" value="R:\XML\Job" />
                <add key="OutputDataFile" value="D:\GA_Data\Output\Txt"/>
                <add key="TempFile" value="R:\"/>
                <add key="ErrorLog" value="D:\GA_Data\ErrorLog"/>
                <add key="DataDirectory" value="R:\" />
                <add key="GASummaryFile"
value="D:\GA_Data\Output\GA\GASummary.dat"/>
                <add key="GAOutPutFile" value="D:\GA_Data\Output\GA\GALog.dat"/>
                <add key="IncludeCost" value="true"/>
                <add key="InputFileName" value="SNGFAM2ST"/>
        </COMMON>
        <XML>
                <add key="OPParamXMLPath" value="D:\GA_Data\OPParam\Params.xml"/>
        </XML>
        <GAPARAM>
        <GAPARAM>
                <add key="Population" value = "50"/>
                <add key="Generation" value = "100"/>
                <add key="pMutation" value="0.01"/>
                <add key="pCrossOver" value="0.9"/>
                <add key="Seed" value="1"/>
        </GAPARAM>
</HOME>
```

Fig. 25. Sample eCalc-Op configuration file

```
<ESL>
        <COMMON>
                <add key="Scenario" value="SNGFAM2ST"/>
                <add key="ConnectionString" value="User
ID=e2calc_DEV;Password=clean07air;Initial Catalog=eCalc_DEV_GA;Data Source=localhost"/>
                <add key="ModelProjectXMLPath" value="D:\GA_Data\Project_Source"/>
                <add key="PollInterval" value="1000"/>
                <add key="XMLProjPath" value="R:\XML\Project" />
                <add key="XMLJobPath" value="R:\XML\Job" />
                <add key="OutputDataFile" value="D:\GA_Data\Output\Txt"/>
                <add key="TempFile" value="R:\"/>
                <add key="ErrorLog" value="D:\GA_Data\ErrorLog"/>
                <add key="DataDirectory" value="R:\" />
                <add key="ErrorLog" value="D:\GA_Data\ErrorLog"/>
                <add key="DataDirectory" value="R:\" />
                <add key="GASummaryFile"
value="D:\GA_Data\Output\GA\GASummary.dat"/>
                <add key="GAOutPutFile" value="D:\GA_Data\Output\GA\GALog.dat"/>
                <add key="IncludeCost" value="true"/>
                <add key="InputFileName" value="SNGFAM2ST"/>
        </COMMON>
        <XML>
                <add key="OPParamXMLPath" value="D:\GA_Data\OPParam"/>
        </XML>
<GAPARAM>
                <add key="Population" value = "50"/>
                <add key="Generation" value = "100"/>
                <add key="pMutation" value="0.01"/>
                <add key="pCrossOver" value="0.9"/>
                <add key="Seed" value="1"/>
</GAPARAM>
</ESL>
</configuration>
```


Fig. 25. (Continued)

```
<?xml version="1.0" standalone="yes"?>
<projRoot>
 <projHeader>
  <projectID>000</projectID>
  <dateCreated>4/21/2005 8:45:07 PM</dateCreated>
  <author>ASPNET</author>
  <xsdVersion>0.4, Release date : 08/19/2004</xsdVersion>
 </projHeader>
 <modelDetails>
  <standard>ASHRAE 90.1</standard>
  <model ID="DOE2" Ver="Unknown version" Desc="Building Calculator">
   <scenario ID="SNGFAM2ST" Desc="Description">
    <sourceType ID="EXCEL" Ver="1.2" Desc="Grad Student Created">
    </sourceType>
    <section ID="BLDG1">
     <parameter varName="b02">TAR</parameter>
     <parameter varName="b01">Q</parameter>
     <parameter varName="b10">1</parameter>
     <parameter varName="b03">0</parameter>
     <parameter varName="b09">2001</parameter>
     <parameter varName="b07">6.67</parameter>
     <parameter varName="b04">60</parameter>
     <parameter varName="b08">3</parameter>
     <parameter varName="b05">30</parameter>
     <parameter varName="b13">1</parameter>
     <parameter varName="b12">1.5</parameter>
     <parameter varName="b06">8</parameter>
     <parameter varName="b11">S</parameter>
    </section>
    <section ID="CONS1">
     <parameter varName="c02">0.5</parameter>
     <parameter varName="c04">26</parameter>
     <parameter varName="c07">0.9</parameter>
     <parameter varName="c05">0.55</parameter>
     <parameter varName="c03">1</parameter>
     <parameter varName="c06">2</parameter>
     <parameter varName="c08">13</parameter>
     <parameter varName="c01">0.9</parameter>
     <parameter varName="c09">0.24</parameter>
     <parameter varName="c15">A</parameter>
     <parameter varName="c10">S</parameter>
     <parameter varName="c11">0.59</parameter>
     <parameter varName="c14">0.7</parameter>
     <parameter varName="c12">0.34</parameter>
     <parameter varName="c13">2</parameter>
```


Fig. 26. Project XML template file for two decision variables case

```xml
      <parameter varName="c21">15</parameter>
      <parameter varName="c24">15</parameter>
      <parameter varName="c23">15</parameter>
      <parameter varName="c22">15</parameter>
      <parameter varName="c25">15</parameter>
      <parameter varName="c16">0.5</parameter>
      <parameter varName="c17">11.5</parameter>
      <parameter varName="c20">.77</parameter>
      <parameter varName="c19">0.44</parameter>
      <parameter varName="c18">0</parameter>
      <parameter varName="c27">F</parameter>
      <parameter varName="c28">A</parameter>
      <parameter varName="c26">11</parameter>
    </section>
    <section ID="SHAD">
      <parameter varName="s01">0</parameter>
      <parameter varName="s02">0</parameter>
      <parameter varName="s03">0</parameter>
      <parameter varName="s04">0</parameter>
    </section>
    <section ID="SPCO1">
      <parameter varName="sp01">2</parameter>
      <parameter varName="sp02">1</parameter>
    </section>
    <section ID="SYST1">
      <parameter varName="sy01">1</parameter>
      <parameter varName="sy02">0</parameter>
      <parameter varName="sy03">0</parameter>
      <parameter varName="sy04">10</parameter>
      <parameter varName="sy10">A</parameter>
      <parameter varName="sy06">6.8</parameter>
      <parameter varName="sy09">0</parameter>
      <parameter varName="sy11">54</parameter>
      <parameter varName="sy05">0.78</parameter>
      <parameter varName="sy07">0</parameter>
      <parameter varName="sy08">0</parameter>
    </section>
   </scenario>
  </model>
 </modelDetails>
</projRoot>
```


Fig. 26. (Continued)

```xml
<?xml version="1.0" standalone="yes"?>
<projRoot>
  <projHeader>
    <projectID>000</projectID>
    <dateCreated>4/21/2005 8:45:07 PM</dateCreated>
    <author>ASPNET</author>
    <xsdVersion>0.4, Release date : 08/19/2004</xsdVersion>
  </projHeader>
  <modelDetails>
    <standard>ASHRAE 90.1</standard>
    <model ID="DOE2" Ver="Unknown version" Desc="Building Calculator">
      <scenario ID="SNGFAM2ST" Desc="Description">
        <sourceType ID="EXCEL" Ver="1.2" Desc="Grad Student Created">
        </sourceType>
        <section ID="BLDG1">
          <parameter varName="b02">TAR</parameter>
          <parameter varName="b01">Q</parameter>
          <parameter varName="b10">1</parameter>
          <parameter varName="b03">0</parameter>
          <parameter varName="b09">2001</parameter>
          <parameter varName="b07">6.67</parameter>
          <parameter varName="b04">60</parameter>
          <parameter varName="b08">3</parameter>
          <parameter varName="b05">30</parameter>
          <parameter varName="b13">1</parameter>
          <parameter varName="b12">1.5</parameter>
          <parameter varName="b06">8</parameter>
          <parameter varName="b11">S</parameter>
        </section>
        <section ID="CONS1">
          <parameter varName="c02">0.5</parameter>
          <parameter varName="c04">26</parameter>
          <parameter varName="c07">0.9</parameter>
          <parameter varName="c05">0.55</parameter>
          <parameter varName="c03">1</parameter>
          <parameter varName="c06">2</parameter>
          <parameter varName="c08">13</parameter>
          <parameter varName="c01">0.9</parameter>
          <parameter varName="c09">0.24</parameter>
          <parameter varName="c15">A</parameter>
          <parameter varName="c10">D</parameter>
          <parameter varName="c11">0.59</parameter>
          <parameter varName="c14">0.7</parameter>
          <parameter varName="c12">0.34</parameter>
          <parameter varName="c13">2</parameter>
          <parameter varName="c21">15</parameter>
          <parameter varName="c24">15</parameter>
```


Fig. 27. Project XML template file for six decision variables case

```xml
      <parameter varName="c23">15</parameter>
      <parameter varName="c22">15</parameter>
      <parameter varName="c25">15</parameter>
      <parameter varName="c16">0.5</parameter>
      <parameter varName="c17">11.5</parameter>
      <parameter varName="c20">.77</parameter>
      <parameter varName="c19">0.44</parameter>
      <parameter varName="c18">0</parameter>
      <parameter varName="c27">F</parameter>
      <parameter varName="c28">A</parameter>
      <parameter varName="c26">11</parameter>
     </section>
     <section ID="SHAD">
      <parameter varName="s01">0</parameter>
      <parameter varName="s02">0</parameter>
      <parameter varName="s03">0</parameter>
      <parameter varName="s04">0</parameter>
     </section>
     <section ID="SPCO1">
      <parameter varName="sp01">2</parameter>
      <parameter varName="sp02">1</parameter>
     </section>
     <section ID="SYST1">
      <parameter varName="sy01">1</parameter>
      <parameter varName="sy02">0</parameter>
      <parameter varName="sy03">0</parameter>
      <parameter varName="sy04">10</parameter>
      <parameter varName="sy10">A</parameter>
      <parameter varName="sy06">6.8</parameter>
      <parameter varName="sy09">0</parameter>
      <parameter varName="sy11">54</parameter>
      <parameter varName="sy05">0.78</parameter>
      <parameter varName="sy07">0</parameter>
      <parameter varName="sy08">0</parameter>
     </section>
    </scenario>
   </model>
  </modelDetails>
</projRoot>
```


Fig. 27. (Continued)

```xml
<?xml version="1.0" standalone="yes"?>
<OPParamDT xmlns="http://tempuri.org/OPParamDT.xsd">
  <tblOPParam>
   <Name>b03</Name>
   <Section>BLDG1</Section>
   <Min>0</Min>
   <Max>360</Max>
   <Value>0</Value>
   <DataType>int</DataType>
   <Step>1</Step>
  </tblOPParam>
 <tblOPParam>
   <Name>sy04</Name>
   <Section>SYST1</Section>
   <Min>8</Min>
   <Max>20</Max>
   <Value>10</Value>
   <DataType>int</DataType>
   <Step>1</Step>
  </tblOPParam>
  <tblOPParam>
   <Name>c21</Name>
   <Section>CONS1</Section>
   <Min>10</Min>
   <Max>80</Max>
   <Value>20</Value>
   <DataType>int</DataType>
   <Step>1</Step>
  </tblOPParam>
  <tblOPParam>
   <Name>c22</Name>
   <Section>CONS1</Section>
   <Min>10</Min>
   <Max>80</Max>
   <Value>20</Value>
   <DataType>int</DataType>
   <Step>1</Step>
  </tblOPParam>
  <tblOPParam>
   <Name>c23</Name>
   <Section>CONS1</Section>
   <Min>10</Min>
   <Max>80</Max>
   <Value>20</Value>
   <DataType>int</DataType>
   <Step>1</Step>
  </tblOPParam>
</OPParamDT>
```


Fig. 28. Sample decision variable definition file

APPENDIX C

Table 19. ANOVA result on two decision variables different population sizes

Gen.	MSb	MSw	F	Fcv	Decision	Gen	MSb	MSw	F	Fcv	Decision
1	640.81	86.05	7.45	2.58	REJECT	51	247.24	53.29	4.64	2.58	REJECT
2	681.44	87.95	7.75	2.58	REJECT	52	246.89	52.12	4.74	2.58	REJECT
3	737.23	86.90	8.48	2.58	REJECT	53	246.89	52.12	4.74	2.58	REJECT
4	792.47	81.56	9.72	2.58	REJECT	54	250.20	52.05	4.81	2.58	REJECT
5	567.02	90.97	6.23	2.58	REJECT	55	251.58	52.04	4.83	2.58	REJECT
6	591.05	91.09	6.49	2.58	REJECT	56	251.58	52.04	4.83	2.58	REJECT
7	499.82	86.87	5.75	2.58	REJECT	57	251.58	52.04	4.83	2.58	REJECT
8	471.18	87.91	5.36	2.58	REJECT	58	251.58	52.04	4.83	2.58	REJECT
9	458.87	78.88	5.82	2.58	REJECT	59	251.58	52.04	4.83	2.58	REJECT
10	470.73	78.58	5.99	2.58	REJECT	60	251.58	52.04	4.83	2.58	REJECT
11	472.10	78.66	6.00	2.58	REJECT	61	251.58	52.04	4.83	2.58	REJECT
12	476.95	78.67	6.06	2.58	REJECT	62	254.28	49.76	5.11	2.58	REJECT
13	479.29	78.68	6.09	2.58	REJECT	63	254.28	49.76	5.11	2.58	REJECT
14	481.39	78.68	6.12	2.58	REJECT	64	262.84	47.57	5.52	2.58	REJECT
15	481.39	78.68	6.12	2.58	REJECT	65	262.99	47.57	5.53	2.58	REJECT
16	468.04	69.24	6.76	2.58	REJECT	66	262.99	47.57	5.53	2.58	REJECT
17	468.04	69.24	6.76	2.58	REJECT	67	262.99	47.57	5.53	2.58	REJECT
18	468.04	69.24	6.76	2.58	REJECT	68	262.99	47.57	5.53	2.58	REJECT
19	468.04	69.24	6.76	2.58	REJECT	69	262.99	47.57	5.53	2.58	REJECT
20	468.04	69.24	6.76	2.58	REJECT	70	243.15	47.00	5.17	2.58	REJECT
21	468.04	69.24	6.76	2.58	REJECT	71	243.15	47.00	5.17	2.58	REJECT
22	468.72	69.53	6.74	2.58	REJECT	72	125.73	38.76	3.24	2.58	REJECT
23	470.82	69.52	6.77	2.58	REJECT	73	125.73	38.76	3.24	2.58	REJECT
24	470.82	69.52	6.77	2.58	REJECT	74	125.73	38.76	3.24	2.58	REJECT
25	470.82	69.52	6.77	2.58	REJECT	75	125.73	38.76	3.24	2.58	REJECT
26	470.82	69.52	6.77	2.58	REJECT	76	125.73	38.76	3.24	2.58	REJECT
27	481.49	68.93	6.99	2.58	REJECT	77	125.73	38.76	3.24	2.58	REJECT
28	473.64	67.30	7.04	2.58	REJECT	78	125.73	38.76	3.24	2.58	REJECT
29	476.15	67.25	7.08	2.58	REJECT	79	125.73	38.76	3.24	2.58	REJECT
30	476.15	67.25	7.08	2.58	REJECT	80	125.73	38.76	3.24	2.58	REJECT
31	476.15	67.25	7.08	2.58	REJECT	81	125.73	38.76	3.24	2.58	REJECT
32	476.93	67.53	7.06	2.58	REJECT	82	125.73	38.76	3.24	2.58	REJECT
33	397.38	56.10	7.08	2.58	REJECT	83	125.73	38.76	3.24	2.58	REJECT
34	397.38	56.10	7.08	2.58	REJECT	84	126.64	38.75	3.27	2.58	REJECT
35	397.38	56.10	7.08	2.58	REJECT	85	128.36	38.68	3.32	2.58	REJECT
36	400.97	56.01	7.16	2.58	REJECT	86	128.36	38.68	3.32	2.58	REJECT
37	400.97	56.01	7.16	2.58	REJECT	87	129.04	38.68	3.34	2.58	REJECT
38	400.97	56.01	7.16	2.58	REJECT	88	129.04	38.68	3.34	2.58	REJECT
39	401.15	56.00	7.16	2.58	REJECT	89	129.04	38.68	3.34	2.58	REJECT
40	406.45	55.91	7.27	2.58	REJECT	90	92.69	24.95	3.72	2.58	REJECT
41	406.45	55.91	7.27	2.58	REJECT	91	92.69	24.95	3.72	2.58	REJECT
42	406.45	55.91	7.27	2.58	REJECT	92	92.69	24.95	3.72	2.58	REJECT
43	406.45	55.91	7.27	2.58	REJECT	93	92.69	24.95	3.72	2.58	REJECT
44	345.42	59.57	5.80	2.58	REJECT	94	92.69	24.95	3.72	2.58	REJECT
45	345.42	59.57	5.80	2.58	REJECT	95	92.69	24.95	3.72	2.58	REJECT
46	345.42	59.57	5.80	2.58	REJECT	96	92.69	24.95	3.72	2.58	REJECT
47	345.42	59.57	5.80	2.58	REJECT	97	92.69	24.95	3.72	2.58	REJECT
48	285.54	51.91	5.50	2.58	REJECT	98	92.35	25.01	3.69	2.58	REJECT
49	245.93	53.29	4.62	2.58	REJECT	99	92.35	25.01	3.69	2.58	REJECT
50	245.93	53.29	4.62	2.58	REJECT	100	92.35	25.01	3.69	2.58	REJECT

Table 20. ANOVA result on six decision variables different population sizes

Gen	MSb	MSw	F	Fcv	Decision	Gen	MSb	MSw	F	Fcv	Decision
1	19126.99	1573.18	12.16	2.58	REJECT	51	9326.87	790.43	11.80	2.58	REJECT
2	27195.31	1328.04	20.48	2.58	REJECT	52	9434.28	778.38	12.12	2.58	REJECT
3	20415.93	1547.20	13.20	2.58	REJECT	53	9434.28	778.38	12.12	2.58	REJECT
4	17682.93	1453.44	12.17	2.58	REJECT	54	9447.24	772.39	12.23	2.58	REJECT
5	17923.42	1618.39	11.07	2.58	REJECT	55	9547.32	772.23	12.36	2.58	REJECT
6	17216.28	1615.59	10.66	2.58	REJECT	56	7458.97	569.27	13.10	2.58	REJECT
7	14874.93	1625.94	9.15	2.58	REJECT	57	7569.27	567.85	13.33	2.58	REJECT
8	14245.47	1673.88	8.51	2.58	REJECT	58	7605.38	567.55	13.40	2.58	REJECT
9	14388.46	1666.35	8.63	2.58	REJECT	59	7589.51	559.75	13.56	2.58	REJECT
10	15336.75	1657.49	9.25	2.58	REJECT	60	7438.61	577.13	12.89	2.58	REJECT
11	16431.36	1651.87	9.95	2.58	REJECT	61	7549.67	566.32	13.33	2.58	REJECT
12	17083.05	1602.93	10.66	2.58	REJECT	62	7635.74	566.30	13.48	2.58	REJECT
13	17238.19	1649.44	10.45	2.58	REJECT	63	7263.59	592.83	12.25	2.58	REJECT
14	16388.30	1681.28	9.75	2.58	REJECT	64	7185.99	597.43	12.03	2.58	REJECT
15	17187.49	1636.80	10.50	2.58	REJECT	65	7192.65	620.42	11.59	2.58	REJECT
16	16875.56	1647.73	10.24	2.58	REJECT	66	7162.60	628.75	11.39	2.58	REJECT
17	16679.96	1570.09	10.62	2.58	REJECT	67	6295.39	672.79	9.36	2.58	REJECT
18	16642.99	1612.70	10.32	2.58	REJECT	68	6339.88	674.12	9.40	2.58	REJECT
19	16732.25	1573.72	10.63	2.58	REJECT	69	5519.35	699.08	7.90	2.58	REJECT
20	16825.08	1580.09	10.65	2.58	REJECT	70	5415.90	704.43	7.69	2.58	REJECT
21	16978.60	1608.92	10.55	2.58	REJECT	71	5467.94	703.24	7.78	2.58	REJECT
22	16133.84	1668.42	9.67	2.58	REJECT	72	5404.87	708.40	7.63	2.58	REJECT
23	15881.60	1675.05	9.48	2.58	REJECT	73	5495.87	708.54	7.76	2.58	REJECT
24	14303.22	1660.25	8.62	2.58	REJECT	74	5487.26	692.98	7.92	2.58	REJECT
25	12177.55	1201.80	10.13	2.58	REJECT	75	5250.57	731.10	7.18	2.58	REJECT
26	11177.19	1111.76	10.05	2.58	REJECT	76	5254.20	729.73	7.20	2.58	REJECT
27	11212.26	1108.94	10.11	2.58	REJECT	77	5267.34	729.39	7.22	2.58	REJECT
28	11528.71	1112.85	10.36	2.58	REJECT	78	5297.27	726.15	7.29	2.58	REJECT
29	11324.92	1075.06	10.53	2.58	REJECT	79	5297.27	726.15	7.29	2.58	REJECT
30	11323.30	1074.05	10.54	2.58	REJECT	80	5317.34	721.06	7.37	2.58	REJECT
31	10996.83	1047.14	10.50	2.58	REJECT	81	5423.12	721.04	7.52	2.58	REJECT
32	11172.83	1013.21	11.03	2.58	REJECT	82	5457.26	718.23	7.60	2.58	REJECT
33	10914.60	1010.61	10.80	2.58	REJECT	83	5435.85	714.86	7.60	2.58	REJECT
34	10835.79	1021.77	10.60	2.58	REJECT	84	5435.68	712.96	7.62	2.58	REJECT
35	10435.28	1009.87	10.33	2.58	REJECT	85	4689.79	702.63	6.67	2.58	REJECT
36	10619.67	1004.95	10.57	2.58	REJECT	86	4732.41	701.91	6.74	2.58	REJECT
37	10654.34	969.70	10.99	2.58	REJECT	87	4762.06	707.18	6.73	2.58	REJECT
38	10710.07	949.89	11.28	2.58	REJECT	88	4717.55	721.44	6.54	2.58	REJECT
39	10829.14	949.59	11.40	2.58	REJECT	89	4717.13	721.65	6.54	2.58	REJECT
40	10769.23	991.09	10.87	2.58	REJECT	90	4716.24	715.99	6.59	2.58	REJECT
41	10655.89	1004.04	10.61	2.58	REJECT	91	4721.34	718.01	6.58	2.58	REJECT
42	9372.13	993.29	9.44	2.58	REJECT	92	4729.47	706.58	6.69	2.58	REJECT
43	9554.24	989.07	9.66	2.58	REJECT	93	4774.79	707.37	6.75	2.58	REJECT
44	9594.43	987.88	9.71	2.58	REJECT	94	4851.57	707.85	6.85	2.58	REJECT
45	9750.99	948.57	10.28	2.58	REJECT	95	4691.23	699.27	6.71	2.58	REJECT
46	9364.77	772.21	12.13	2.58	REJECT	96	4630.69	693.17	6.68	2.58	REJECT
47	9282.45	777.23	11.94	2.58	REJECT	97	4673.42	690.36	6.77	2.58	REJECT
48	9401.50	781.44	12.03	2.58	REJECT	98	4673.42	690.36	6.77	2.58	REJECT
49	9320.71	769.61	12.11	2.58	REJECT	99	4539.07	646.46	7.02	2.58	REJECT
50	9326.87	790.43	11.80	2.58	REJECT	100	4352.28	603.22	7.22	2.58	REJECT

Table 21. ANOVA result on two decision variables different crossover rates

Gen.	MSb	MSw	F	Fcv	Decision	Gen.	MSb	MSw	F	Fcv	Decision
1	640.81	86.05	7.45	2.58	REJECT	51	247.24	53.29	4.64	2.58	REJECT
2	681.44	87.95	7.75	2.58	REJECT	52	246.89	52.12	4.74	2.58	REJECT
3	737.23	86.90	8.48	2.58	REJECT	53	246.89	52.12	4.74	2.58	REJECT
4	792.47	81.56	9.72	2.58	REJECT	54	250.20	52.05	4.81	2.58	REJECT
5	567.02	90.97	6.23	2.58	REJECT	55	251.58	52.04	4.83	2.58	REJECT
6	591.05	91.09	6.49	2.58	REJECT	56	251.58	52.04	4.83	2.58	REJECT
7	499.82	86.87	5.75	2.58	REJECT	57	251.58	52.04	4.83	2.58	REJECT
8	471.18	87.91	5.36	2.58	REJECT	58	251.58	52.04	4.83	2.58	REJECT
9	458.87	78.88	5.82	2.58	REJECT	59	251.58	52.04	4.83	2.58	REJECT
10	470.73	78.58	5.99	2.58	REJECT	60	251.58	52.04	4.83	2.58	REJECT
11	472.10	78.66	6.00	2.58	REJECT	61	251.58	52.04	4.83	2.58	REJECT
12	476.95	78.67	6.06	2.58	REJECT	62	254.28	49.76	5.11	2.58	REJECT
13	479.29	78.68	6.09	2.58	REJECT	63	254.28	49.76	5.11	2.58	REJECT
14	481.39	78.68	6.12	2.58	REJECT	64	262.84	47.57	5.52	2.58	REJECT
15	481.39	78.68	6.12	2.58	REJECT	65	262.99	47.57	5.53	2.58	REJECT
16	468.04	69.24	6.76	2.58	REJECT	66	262.99	47.57	5.53	2.58	REJECT
17	468.04	69.24	6.76	2.58	REJECT	67	262.99	47.57	5.53	2.58	REJECT
18	468.04	69.24	6.76	2.58	REJECT	68	262.99	47.57	5.53	2.58	REJECT
19	468.04	69.24	6.76	2.58	REJECT	69	262.99	47.57	5.53	2.58	REJECT
20	468.04	69.24	6.76	2.58	REJECT	70	243.15	47.00	5.17	2.58	REJECT
21	468.04	69.24	6.76	2.58	REJECT	71	243.15	47.00	5.17	2.58	REJECT
22	468.72	69.53	6.74	2.58	REJECT	72	125.73	38.76	3.24	2.58	REJECT
23	470.82	69.52	6.77	2.58	REJECT	73	125.73	38.76	3.24	2.58	REJECT
24	470.82	69.52	6.77	2.58	REJECT	74	125.73	38.76	3.24	2.58	REJECT
25	470.82	69.52	6.77	2.58	REJECT	75	125.73	38.76	3.24	2.58	REJECT
26	470.82	69.52	6.77	2.58	REJECT	76	125.73	38.76	3.24	2.58	REJECT
27	481.49	68.93	6.99	2.58	REJECT	77	125.73	38.76	3.24	2.58	REJECT
28	473.64	67.30	7.04	2.58	REJECT	78	125.73	38.76	3.24	2.58	REJECT
29	476.15	67.25	7.08	2.58	REJECT	79	125.73	38.76	3.24	2.58	REJECT
30	476.15	67.25	7.08	2.58	REJECT	80	125.73	38.76	3.24	2.58	REJECT
31	476.15	67.25	7.08	2.58	REJECT	81	125.73	38.76	3.24	2.58	REJECT
32	476.93	67.53	7.06	2.58	REJECT	82	125.73	38.76	3.24	2.58	REJECT
33	397.38	56.10	7.08	2.58	REJECT	83	125.73	38.76	3.24	2.58	REJECT
34	397.38	56.10	7.08	2.58	REJECT	84	126.64	38.75	3.27	2.58	REJECT
35	397.38	56.10	7.08	2.58	REJECT	85	128.36	38.68	3.32	2.58	REJECT
36	400.97	56.01	7.16	2.58	REJECT	86	128.36	38.68	3.32	2.58	REJECT
37	400.97	56.01	7.16	2.58	REJECT	87	129.04	38.68	3.34	2.58	REJECT
38	400.97	56.01	7.16	2.58	REJECT	88	129.04	38.68	3.34	2.58	REJECT
39	401.15	56.00	7.16	2.58	REJECT	89	129.04	38.68	3.34	2.58	REJECT
40	406.45	55.91	7.27	2.58	REJECT	90	92.69	24.95	3.72	2.58	REJECT
41	406.45	55.91	7.27	2.58	REJECT	91	92.69	24.95	3.72	2.58	REJECT
42	406.45	55.91	7.27	2.58	REJECT	92	92.69	24.95	3.72	2.58	REJECT
43	406.45	55.91	7.27	2.58	REJECT	93	92.69	24.95	3.72	2.58	REJECT
44	345.42	59.57	5.80	2.58	REJECT	94	92.69	24.95	3.72	2.58	REJECT
45	345.42	59.57	5.80	2.58	REJECT	95	92.69	24.95	3.72	2.58	REJECT
46	345.42	59.57	5.80	2.58	REJECT	96	92.69	24.95	3.72	2.58	REJECT
47	345.42	59.57	5.80	2.58	REJECT	97	92.69	24.95	3.72	2.58	REJECT
48	285.54	51.91	5.50	2.58	REJECT	98	92.35	25.01	3.69	2.58	REJECT
49	245.93	53.29	4.62	2.58	REJECT	99	92.35	25.01	3.69	2.58	REJECT
50	245.93	53.29	4.62	2.58	REJECT	100	92.35	25.01	3.69	2.58	REJECT

Table 22. ANOVA result on six decision variables different crossover rates

Gen.	MSb	MSw	F	Fcv	Decision	Gen.	MSb	MSw	F	Fcv	Decision
1	0.00	617.68	0.00	2.87	ACCEPT	51	799.48	187.33	4.27	2.87	REJECT
2	389.49	775.69	0.50	2.87	ACCEPT	52	811.50	153.56	5.28	2.87	REJECT
3	658.44	576.04	1.14	2.87	ACCEPT	53	799.29	155.68	5.13	2.87	REJECT
4	595.04	494.47	1.20	2.87	ACCEPT	54	798.45	140.83	5.67	2.87	REJECT
5	315.33	446.37	0.71	2.87	ACCEPT	55	678.47	144.32	4.70	2.87	REJECT
6	716.45	485.87	1.47	2.87	ACCEPT	56	667.28	147.07	4.54	2.87	REJECT
7	938.87	404.25	2.32	2.87	ACCEPT	57	566.59	148.92	3.80	2.87	REJECT
8	1454.14	383.93	3.79	2.87	REJECT	58	455.41	158.49	2.87	2.87	REJECT
9	982.52	437.69	2.24	2.87	ACCEPT	59	467.00	161.93	2.88	2.87	REJECT
10	1288.95	290.66	4.43	2.87	REJECT	60	474.43	162.02	2.93	2.87	REJECT
11	924.27	284.88	3.24	2.87	REJECT	61	388.01	104.86	3.70	2.87	REJECT
12	966.20	282.08	3.43	2.87	REJECT	62	420.99	98.25	4.28	2.87	REJECT
13	840.90	311.65	2.70	2.87	ACCEPT	63	418.15	97.20	4.30	2.87	REJECT
14	1024.09	313.23	3.27	2.87	REJECT	64	436.58	92.89	4.70	2.87	REJECT
15	1074.45	329.02	3.27	2.87	REJECT	65	430.53	93.60	4.60	2.87	REJECT
16	1200.75	316.55	3.79	2.87	REJECT	66	423.39	93.21	4.54	2.87	REJECT
17	1372.76	324.25	4.23	2.87	REJECT	67	449.87	90.42	4.98	2.87	REJECT
18	1432.49	326.52	4.39	2.87	REJECT	68	456.46	90.47	5.05	2.87	REJECT
19	1548.03	336.84	4.60	2.87	REJECT	69	398.05	81.67	4.87	2.87	REJECT
20	1548.02	343.98	4.50	2.87	REJECT	70	406.05	83.07	4.89	2.87	REJECT
21	1815.87	330.56	5.49	2.87	REJECT	71	427.85	80.74	5.30	2.87	REJECT
22	1461.58	307.71	4.75	2.87	REJECT	72	396.28	76.05	5.21	2.87	REJECT
23	1271.36	302.24	4.21	2.87	REJECT	73	372.76	80.65	4.62	2.87	REJECT
24	973.09	309.21	3.15	2.87	REJECT	74	364.02	77.88	4.67	2.87	REJECT
25	1049.26	292.51	3.59	2.87	REJECT	75	354.02	76.70	4.62	2.87	REJECT
26	1049.26	292.51	3.59	2.87	REJECT	76	302.16	65.55	4.61	2.87	REJECT
27	1095.86	306.45	3.58	2.87	REJECT	77	280.99	65.52	4.29	2.87	REJECT
28	1001.93	297.43	3.37	2.87	REJECT	78	325.20	69.25	4.70	2.87	REJECT
29	1021.23	304.41	3.35	2.87	REJECT	79	312.59	63.61	4.91	2.87	REJECT
30	884.86	304.97	2.90	2.87	REJECT	80	312.59	63.61	4.91	2.87	REJECT
31	956.82	288.34	3.32	2.87	REJECT	81	317.16	63.04	5.03	2.87	REJECT
32	858.57	328.96	2.61	2.87	ACCEPT	82	328.05	60.44	5.43	2.87	REJECT
33	743.26	323.51	2.30	2.87	ACCEPT	83	328.05	60.44	5.43	2.87	REJECT
34	764.56	322.74	2.37	2.87	ACCEPT	84	297.20	60.65	4.90	2.87	REJECT
35	765.04	322.53	2.37	2.87	ACCEPT	85	307.33	60.51	5.08	2.87	REJECT
36	653.95	276.83	2.36	2.87	ACCEPT	86	274.09	54.90	4.99	2.87	REJECT
37	682.73	257.00	2.66	2.87	ACCEPT	87	282.68	54.47	5.19	2.87	REJECT
38	787.77	219.54	3.59	2.87	REJECT	88	293.47	54.46	5.39	2.87	REJECT
39	720.32	226.42	3.18	2.87	REJECT	89	293.41	54.64	5.37	2.87	REJECT
40	803.40	241.05	3.33	2.87	REJECT	90	230.70	63.57	3.63	2.87	REJECT
41	793.05	247.54	3.20	2.87	REJECT	91	192.17	60.43	3.18	2.87	REJECT
42	944.52	207.66	4.55	2.87	REJECT	92	196.21	57.39	3.42	2.87	REJECT
43	1036.62	205.08	5.05	2.87	REJECT	93	193.19	55.82	3.46	2.87	REJECT
44	1036.83	205.53	5.04	2.87	REJECT	94	167.28	52.69	3.17	2.87	REJECT
45	1032.84	212.16	4.87	2.87	REJECT	95	171.54	53.05	3.23	2.87	REJECT
46	1074.20	215.12	4.99	2.87	REJECT	96	170.66	52.22	3.27	2.87	REJECT
47	938.05	196.64	4.77	2.87	REJECT	97	177.28	51.17	3.46	2.87	REJECT
48	970.45	184.14	5.27	2.87	REJECT	98	166.28	50.87	3.27	2.87	REJECT
49	974.03	180.31	5.40	2.87	REJECT	99	171.30	51.83	3.31	2.87	REJECT
50	941.57	178.39	5.28	2.87	REJECT	100	170.36	45.29	3.76	2.87	REJECT

Table 22. (Continued)

Gen.	MSb	MSw	F	Fcv	Decision	Gen.	MSb	MSw	F	Fcv	Decision
101	179.60	47.94	3.75	2.87	REJECT	151	95.92	46.12	2.08	2.87	ACCEPT
102	180.68	48.24	3.75	2.87	REJECT	152	93.58	46.89	2.00	2.87	ACCEPT
103	183.28	49.75	3.68	2.87	REJECT	153	78.91	43.52	1.81	2.87	ACCEPT
104	204.98	50.78	4.04	2.87	REJECT	154	76.91	43.46	1.77	2.87	ACCEPT
105	206.16	50.77	4.06	2.87	REJECT	155	78.31	43.33	1.81	2.87	ACCEPT
106	202.14	43.29	4.67	2.87	REJECT	156	78.31	43.33	1.81	2.87	ACCEPT
107	167.00	45.17	3.70	2.87	REJECT	157	78.40	42.90	1.83	2.87	ACCEPT
108	155.74	47.80	3.26	2.87	REJECT	158	79.22	42.37	1.87	2.87	ACCEPT
109	158.47	47.43	3.34	2.87	REJECT	159	82.60	43.87	1.88	2.87	ACCEPT
110	129.61	43.74	2.96	2.87	REJECT	160	88.56	46.70	1.90	2.87	ACCEPT
111	129.61	43.74	2.96	2.87	REJECT	161	88.56	46.70	1.90	2.87	ACCEPT
112	129.74	43.56	2.98	2.87	REJECT	162	90.57	47.33	1.91	2.87	ACCEPT
113	129.74	43.56	2.98	2.87	REJECT	163	91.33	47.30	1.93	2.87	ACCEPT
114	85.06	42.04	2.02	2.87	ACCEPT	164	94.88	47.25	2.01	2.87	ACCEPT
115	87.29	42.36	2.06	2.87	ACCEPT	165	86.96	46.89	1.85	2.87	ACCEPT
116	82.29	43.62	1.89	2.87	ACCEPT	166	86.96	46.89	1.85	2.87	ACCEPT
117	82.29	43.62	1.89	2.87	ACCEPT	167	87.48	46.94	1.86	2.87	ACCEPT
118	86.22	39.38	2.19	2.87	ACCEPT	168	87.48	46.94	1.86	2.87	ACCEPT
119	71.89	42.14	1.71	2.87	ACCEPT	169	87.48	46.94	1.86	2.87	ACCEPT
120	68.38	41.48	1.65	2.87	ACCEPT	170	95.09	47.97	1.98	2.87	ACCEPT
121	68.38	41.48	1.65	2.87	ACCEPT	171	95.09	47.97	1.98	2.87	ACCEPT
122	73.27	41.44	1.77	2.87	ACCEPT	172	95.09	47.97	1.98	2.87	ACCEPT
123	68.84	41.25	1.67	2.87	ACCEPT	173	94.79	48.01	1.97	2.87	ACCEPT
124	79.62	41.26	1.93	2.87	ACCEPT	174	94.79	48.01	1.97	2.87	ACCEPT
125	85.20	38.23	2.23	2.87	ACCEPT	175	94.79	48.01	1.97	2.87	ACCEPT
126	85.20	38.23	2.23	2.87	ACCEPT	176	91.20	48.65	1.87	2.87	ACCEPT
127	85.20	38.23	2.23	2.87	ACCEPT	177	91.20	48.65	1.87	2.87	ACCEPT
128	89.36	38.18	2.34	2.87	ACCEPT	178	91.20	48.65	1.87	2.87	ACCEPT
129	90.46	38.72	2.34	2.87	ACCEPT	179	83.40	48.17	1.73	2.87	ACCEPT
130	94.04	37.72	2.49	2.87	ACCEPT	180	83.40	48.17	1.73	2.87	ACCEPT
131	102.40	39.13	2.62	2.87	ACCEPT	181	88.47	45.69	1.94	2.87	ACCEPT
132	98.66	38.68	2.55	2.87	ACCEPT	182	88.47	45.69	1.94	2.87	ACCEPT
133	98.66	38.68	2.55	2.87	ACCEPT	183	59.17	50.13	1.18	2.87	ACCEPT
134	98.66	38.68	2.55	2.87	ACCEPT	184	61.74	50.53	1.22	2.87	ACCEPT
135	99.65	38.81	2.57	2.87	ACCEPT	185	61.74	50.53	1.22	2.87	ACCEPT
136	94.11	39.62	2.38	2.87	ACCEPT	186	60.70	40.33	1.51	2.87	ACCEPT
137	94.11	39.62	2.38	2.87	ACCEPT	187	61.15	39.78	1.54	2.87	ACCEPT
138	82.35	40.10	2.05	2.87	ACCEPT	188	63.41	39.89	1.59	2.87	ACCEPT
139	88.55	38.76	2.28	2.87	ACCEPT	189	60.97	39.23	1.55	2.87	ACCEPT
140	89.51	38.69	2.31	2.87	ACCEPT	190	60.97	39.23	1.55	2.87	ACCEPT
141	98.10	40.13	2.44	2.87	ACCEPT	191	60.97	39.23	1.55	2.87	ACCEPT
142	101.49	42.43	2.39	2.87	ACCEPT	192	60.97	39.23	1.55	2.87	ACCEPT
143	90.88	42.59	2.13	2.87	ACCEPT	193	50.35	37.23	1.35	2.87	ACCEPT
144	91.74	41.34	2.22	2.87	ACCEPT	194	54.72	35.68	1.53	2.87	ACCEPT
145	91.73	41.47	2.21	2.87	ACCEPT	195	54.04	35.92	1.50	2.87	ACCEPT
146	93.05	41.46	2.24	2.87	ACCEPT	196	54.04	35.92	1.50	2.87	ACCEPT
147	93.26	42.33	2.20	2.87	ACCEPT	197	70.37	30.70	2.29	2.87	ACCEPT
148	85.78	41.14	2.09	2.87	ACCEPT	198	65.99	30.33	2.18	2.87	ACCEPT
149	86.16	41.50	2.08	2.87	ACCEPT	199	69.51	30.37	2.29	2.87	ACCEPT
150	89.14	44.84	1.99	2.87	ACCEPT	200	69.51	30.37	2.29	2.87	ACCEPT

Table 23. ANOVA result on two decision variables different mutation rates

Gen.	MSb	MSw	F	Fcv	Decision	Gen.	MSb	MSw	F	Fcv	Decision
1	0.00	9.24	0.00	2.87	ACCEPT	51	0.81	0.45	1.79	2.87	ACCEPT
2	1.55	7.51	0.21	2.87	ACCEPT	52	0.81	0.45	1.79	2.87	ACCEPT
3	5.62	6.84	0.82	2.87	ACCEPT	53	0.97	0.42	2.33	2.87	ACCEPT
4	3.59	5.41	0.66	2.87	ACCEPT	54	0.97	0.42	2.33	2.87	ACCEPT
5	2.21	4.47	0.49	2.87	ACCEPT	55	0.97	0.42	2.33	2.87	ACCEPT
6	2.68	3.24	0.83	2.87	ACCEPT	56	1.13	0.40	2.83	2.87	ACCEPT
7	2.18	3.12	0.70	2.87	ACCEPT	57	1.13	0.40	2.83	2.87	ACCEPT
8	3.10	3.08	1.01	2.87	ACCEPT	58	1.13	0.40	2.83	2.87	ACCEPT
9	3.99	2.24	1.78	2.87	ACCEPT	59	1.14	0.40	2.86	2.87	ACCEPT
10	4.30	2.23	1.93	2.87	ACCEPT	60	1.16	0.40	2.91	2.87	REJECT
11	4.28	2.26	1.90	2.87	ACCEPT	61	1.16	0.40	2.91	2.87	REJECT
12	4.39	2.26	1.94	2.87	ACCEPT	62	1.16	0.40	2.91	2.87	REJECT
13	4.39	2.26	1.94	2.87	ACCEPT	63	1.10	0.38	2.88	2.87	REJECT
14	4.39	2.14	2.06	2.87	ACCEPT	64	1.10	0.38	2.88	2.87	REJECT
15	3.43	2.21	1.56	2.87	ACCEPT	65	1.01	0.36	2.82	2.87	ACCEPT
16	2.63	2.27	1.16	2.87	ACCEPT	66	1.07	0.35	3.02	2.87	REJECT
17	2.63	2.27	1.16	2.87	ACCEPT	67	1.09	0.35	3.12	2.87	REJECT
18	2.74	2.22	1.23	2.87	ACCEPT	68	1.09	0.35	3.12	2.87	REJECT
19	2.87	2.22	1.29	2.87	ACCEPT	69	1.09	0.35	3.12	2.87	REJECT
20	2.87	2.22	1.29	2.87	ACCEPT	70	1.09	0.35	3.12	2.87	REJECT
21	2.87	2.22	1.29	2.87	ACCEPT	71	1.11	0.35	3.17	2.87	REJECT
22	2.42	2.08	1.17	2.87	ACCEPT	72	1.11	0.35	3.17	2.87	REJECT
23	2.42	2.08	1.17	2.87	ACCEPT	73	1.11	0.35	3.17	2.87	REJECT
24	2.15	2.04	1.06	2.87	ACCEPT	74	1.11	0.35	3.17	2.87	REJECT
25	2.15	2.04	1.06	2.87	ACCEPT	75	0.77	0.28	2.72	2.87	ACCEPT
26	1.84	2.08	0.88	2.87	ACCEPT	76	0.77	0.28	2.72	2.87	ACCEPT
27	1.90	2.08	0.92	2.87	ACCEPT	77	0.77	0.28	2.72	2.87	ACCEPT
28	2.05	2.06	1.00	2.87	ACCEPT	78	0.77	0.28	2.72	2.87	ACCEPT
29	2.09	2.07	1.01	2.87	ACCEPT	79	0.77	0.28	2.72	2.87	ACCEPT
30	2.09	2.07	1.01	2.87	ACCEPT	80	0.77	0.28	2.72	2.87	ACCEPT
31	1.86	2.06	0.90	2.87	ACCEPT	81	0.77	0.28	2.72	2.87	ACCEPT
32	1.86	2.06	0.90	2.87	ACCEPT	82	0.77	0.28	2.72	2.87	ACCEPT
33	1.88	2.07	0.91	2.87	ACCEPT	83	0.74	0.18	4.08	2.87	REJECT
34	1.88	2.07	0.91	2.87	ACCEPT	84	0.74	0.18	4.08	2.87	REJECT
35	1.70	0.62	2.72	2.87	ACCEPT	85	0.74	0.17	4.26	2.87	REJECT
36	1.70	0.62	2.72	2.87	ACCEPT	86	0.74	0.17	4.26	2.87	REJECT
37	1.70	0.62	2.72	2.87	ACCEPT	87	0.74	0.17	4.26	2.87	REJECT
38	1.70	0.62	2.72	2.87	ACCEPT	88	0.74	0.17	4.26	2.87	REJECT
39	1.78	0.63	2.83	2.87	ACCEPT	89	0.72	0.18	4.03	2.87	REJECT
40	1.86	0.52	3.62	2.87	REJECT	90	0.72	0.18	4.03	2.87	REJECT
41	1.86	0.52	3.62	2.87	REJECT	91	0.72	0.18	4.03	2.87	REJECT
42	1.57	0.52	3.00	2.87	REJECT	92	0.72	0.18	4.03	2.87	REJECT
43	1.89	0.45	4.21	2.87	REJECT	93	0.72	0.18	4.03	2.87	REJECT
44	1.49	0.48	3.08	2.87	REJECT	94	0.72	0.18	4.03	2.87	REJECT
45	1.49	0.48	3.08	2.87	REJECT	95	0.72	0.18	4.03	2.87	REJECT
46	1.48	0.47	3.12	2.87	REJECT	96	0.72	0.18	4.03	2.87	REJECT
47	1.49	0.48	3.14	2.87	REJECT	97	0.72	0.18	4.03	2.87	REJECT
48	0.87	0.46	1.86	2.87	ACCEPT	98	0.72	0.18	4.03	2.87	REJECT
49	0.88	0.46	1.90	2.87	ACCEPT	99	0.74	0.18	4.19	2.87	REJECT
50	0.88	0.46	1.90	2.87	ACCEPT	100	0.74	0.18	4.19	2.87	REJECT

Table 24. ANOVA result on six decision variables different mutation rates

Gen.	MSb	MSw	F	Fcv	Decision	Gen.	MSb	MSw	F	Fcv	Decision
1	0.00	617.68	0.00	2.87	ACCEPT	51	335.45	122.70	2.73	2.87	ACCEPT
2	824.94	574.89	1.43	2.87	ACCEPT	52	294.12	99.31	2.96	2.87	REJECT
3	581.26	416.50	1.40	2.87	ACCEPT	53	294.09	98.10	3.00	2.87	REJECT
4	301.43	304.79	0.99	2.87	ACCEPT	54	282.40	93.85	3.01	2.87	REJECT
5	601.67	362.23	1.66	2.87	ACCEPT	55	283.62	97.40	2.91	2.87	REJECT
6	135.05	488.49	0.28	2.87	ACCEPT	56	302.55	94.35	3.21	2.87	REJECT
7	58.85	559.88	0.11	2.87	ACCEPT	57	290.66	88.91	3.27	2.87	REJECT
8	45.19	531.16	0.09	2.87	ACCEPT	58	404.60	79.19	5.11	2.87	REJECT
9	38.20	510.54	0.07	2.87	ACCEPT	59	381.04	84.31	4.52	2.87	REJECT
10	75.54	391.02	0.19	2.87	ACCEPT	60	364.30	80.33	4.53	2.87	REJECT
11	10.94	395.70	0.03	2.87	ACCEPT	61	342.46	58.08	5.90	2.87	REJECT
12	40.75	370.34	0.11	2.87	ACCEPT	62	330.05	55.51	5.95	2.87	REJECT
13	91.43	345.83	0.26	2.87	ACCEPT	63	360.59	55.28	6.52	2.87	REJECT
14	9.45	325.08	0.03	2.87	ACCEPT	64	317.94	55.06	5.77	2.87	REJECT
15	35.59	302.78	0.12	2.87	ACCEPT	65	302.62	56.28	5.38	2.87	REJECT
16	85.87	313.98	0.27	2.87	ACCEPT	66	300.02	54.49	5.51	2.87	REJECT
17	152.15	296.86	0.51	2.87	ACCEPT	67	292.72	54.51	5.37	2.87	REJECT
18	164.05	288.44	0.57	2.87	ACCEPT	68	271.79	53.45	5.09	2.87	REJECT
19	126.74	290.75	0.44	2.87	ACCEPT	69	280.18	53.22	5.26	2.87	REJECT
20	313.73	311.23	1.01	2.87	ACCEPT	70	303.13	54.24	5.59	2.87	REJECT
21	399.61	275.84	1.45	2.87	ACCEPT	71	285.70	52.24	5.47	2.87	REJECT
22	507.55	264.38	1.92	2.87	ACCEPT	72	301.61	51.88	5.81	2.87	REJECT
23	636.75	249.00	2.56	2.87	ACCEPT	73	288.54	51.98	5.55	2.87	REJECT
24	636.05	230.36	2.76	2.87	ACCEPT	74	305.20	52.61	5.80	2.87	REJECT
25	747.90	201.09	3.72	2.87	REJECT	75	285.93	54.10	5.29	2.87	REJECT
26	808.60	186.59	4.33	2.87	REJECT	76	340.35	47.99	7.09	2.87	REJECT
27	755.05	188.02	4.02	2.87	REJECT	77	339.58	47.82	7.10	2.87	REJECT
28	785.27	186.81	4.20	2.87	REJECT	78	304.38	48.43	6.28	2.87	REJECT
29	768.67	188.44	4.08	2.87	REJECT	79	304.38	48.43	6.28	2.87	REJECT
30	828.98	186.31	4.45	2.87	REJECT	80	306.47	48.58	6.31	2.87	REJECT
31	921.29	177.63	5.19	2.87	REJECT	81	292.89	48.01	6.10	2.87	REJECT
32	923.28	189.88	4.86	2.87	REJECT	82	289.70	43.95	6.59	2.87	REJECT
33	918.73	185.48	4.95	2.87	REJECT	83	290.55	43.97	6.61	2.87	REJECT
34	942.71	174.76	5.39	2.87	REJECT	84	290.55	43.97	6.61	2.87	REJECT
35	1041.41	177.97	5.85	2.87	REJECT	85	271.30	41.16	6.59	2.87	REJECT
36	875.63	176.66	4.96	2.87	REJECT	86	254.22	40.02	6.35	2.87	REJECT
37	962.59	157.34	6.12	2.87	REJECT	87	233.75	40.01	5.84	2.87	REJECT
38	970.27	141.84	6.84	2.87	REJECT	88	284.45	38.25	7.44	2.87	REJECT
39	966.79	142.58	6.78	2.87	REJECT	89	296.68	37.51	7.91	2.87	REJECT
40	937.93	161.72	5.80	2.87	REJECT	90	296.68	37.51	7.91	2.87	REJECT
41	937.63	165.30	5.67	2.87	REJECT	91	296.68	37.51	7.91	2.87	REJECT
42	872.72	128.55	6.79	2.87	REJECT	92	279.27	34.47	8.10	2.87	REJECT
43	737.11	125.43	5.88	2.87	REJECT	93	278.27	33.84	8.22	2.87	REJECT
44	698.01	125.90	5.54	2.87	REJECT	94	252.49	35.66	7.08	2.87	REJECT
45	591.65	131.92	4.48	2.87	REJECT	95	274.33	32.22	8.51	2.87	REJECT
46	518.20	134.87	3.84	2.87	REJECT	96	274.33	32.22	8.51	2.87	REJECT
47	459.42	133.58	3.44	2.87	REJECT	97	264.46	31.30	8.45	2.87	REJECT
48	357.76	135.78	2.63	2.87	ACCEPT	98	264.46	31.30	8.45	2.87	REJECT
49	336.38	128.60	2.62	2.87	ACCEPT	99	269.26	32.24	8.35	2.87	REJECT
50	334.71	122.79	2.73	2.87	ACCEPT	100	251.03	29.69	8.45	2.87	REJECT

Table 24. (Continued)

Gen.	MSb	MSw	F	Fcv	Decision	Gen.	MSb	MSw	F	Fcv	Decision
101	251.03	29.69	8.45	2.87	REJECT	151	161.62	28.35	5.70	2.87	REJECT
102	264.82	31.88	8.31	2.87	REJECT	152	154.96	28.17	5.50	2.87	REJECT
103	262.86	32.11	8.19	2.87	REJECT	153	162.11	27.05	5.99	2.87	REJECT
104	224.77	33.15	6.78	2.87	REJECT	154	158.05	27.07	5.84	2.87	REJECT
105	224.07	33.21	6.75	2.87	REJECT	155	159.56	27.07	5.89	2.87	REJECT
106	205.24	30.48	6.73	2.87	REJECT	156	159.56	27.07	5.89	2.87	REJECT
107	207.02	30.47	6.79	2.87	REJECT	157	158.64	26.61	5.96	2.87	REJECT
108	214.62	29.46	7.28	2.87	REJECT	158	153.93	26.39	5.83	2.87	REJECT
109	225.23	28.80	7.82	2.87	REJECT	159	139.59	27.12	5.15	2.87	REJECT
110	237.10	29.76	7.97	2.87	REJECT	160	140.57	27.20	5.17	2.87	REJECT
111	231.71	30.56	7.58	2.87	REJECT	161	140.57	27.20	5.17	2.87	REJECT
112	231.71	30.56	7.58	2.87	REJECT	162	136.69	27.83	4.91	2.87	REJECT
113	231.71	30.56	7.58	2.87	REJECT	163	132.62	27.81	4.77	2.87	REJECT
114	239.54	30.04	7.97	2.87	REJECT	164	127.60	28.17	4.53	2.87	REJECT
115	239.54	30.04	7.97	2.87	REJECT	165	120.39	28.32	4.25	2.87	REJECT
116	234.51	30.33	7.73	2.87	REJECT	166	120.39	28.32	4.25	2.87	REJECT
117	243.77	30.39	8.02	2.87	REJECT	167	133.71	28.37	4.71	2.87	REJECT
118	220.72	25.74	8.57	2.87	REJECT	168	133.71	28.37	4.71	2.87	REJECT
119	222.36	25.88	8.59	2.87	REJECT	169	143.08	28.92	4.95	2.87	REJECT
120	222.36	25.88	8.59	2.87	REJECT	170	132.32	29.96	4.42	2.87	REJECT
121	223.50	25.80	8.66	2.87	REJECT	171	132.32	29.96	4.42	2.87	REJECT
122	217.95	25.56	8.53	2.87	REJECT	172	132.32	29.96	4.42	2.87	REJECT
123	210.91	25.36	8.32	2.87	REJECT	173	132.32	29.96	4.42	2.87	REJECT
124	200.92	25.65	7.83	2.87	REJECT	174	136.33	30.22	4.51	2.87	REJECT
125	177.07	22.69	7.80	2.87	REJECT	175	136.33	30.22	4.51	2.87	REJECT
126	177.07	22.69	7.80	2.87	REJECT	176	137.21	30.64	4.48	2.87	REJECT
127	177.07	22.69	7.80	2.87	REJECT	177	137.21	30.64	4.48	2.87	REJECT
128	172.59	22.64	7.62	2.87	REJECT	178	137.21	30.64	4.48	2.87	REJECT
129	174.65	22.60	7.73	2.87	REJECT	179	139.54	30.79	4.53	2.87	REJECT
130	165.69	22.38	7.40	2.87	REJECT	180	157.71	29.46	5.35	2.87	REJECT
131	160.86	23.07	6.97	2.87	REJECT	181	161.91	26.44	6.12	2.87	REJECT
132	160.86	23.07	6.97	2.87	REJECT	182	163.37	26.40	6.19	2.87	REJECT
133	173.91	23.23	7.49	2.87	REJECT	183	162.64	26.22	6.20	2.87	REJECT
134	200.21	21.98	9.11	2.87	REJECT	184	155.84	26.28	5.93	2.87	REJECT
135	200.21	21.98	9.11	2.87	REJECT	185	155.84	26.28	5.93	2.87	REJECT
136	193.02	21.66	8.91	2.87	REJECT	186	134.05	23.42	5.72	2.87	REJECT
137	195.64	21.52	9.09	2.87	REJECT	187	134.05	23.42	5.72	2.87	REJECT
138	190.03	23.14	8.21	2.87	REJECT	188	128.12	23.57	5.43	2.87	REJECT
139	183.95	21.66	8.49	2.87	REJECT	189	128.12	23.57	5.43	2.87	REJECT
140	179.17	21.61	8.29	2.87	REJECT	190	133.23	23.72	5.62	2.87	REJECT
141	169.26	23.05	7.34	2.87	REJECT	191	133.23	23.72	5.62	2.87	REJECT
142	141.61	27.18	5.21	2.87	REJECT	192	133.23	23.72	5.62	2.87	REJECT
143	151.95	26.53	5.73	2.87	REJECT	193	133.22	23.75	5.61	2.87	REJECT
144	146.59	25.29	5.80	2.87	REJECT	194	128.53	20.19	6.37	2.87	REJECT
145	149.52	26.35	5.68	2.87	REJECT	195	128.53	20.19	6.37	2.87	REJECT
146	165.68	27.06	6.12	2.87	REJECT	196	128.53	20.19	6.37	2.87	REJECT
147	165.68	27.06	6.12	2.87	REJECT	197	117.71	18.27	6.44	2.87	REJECT
148	165.68	27.06	6.12	2.87	REJECT	198	113.33	18.53	6.12	2.87	REJECT
149	165.68	27.06	6.12	2.87	REJECT	199	109.47	19.20	5.70	2.87	REJECT
150	165.68	27.06	6.12	2.87	REJECT	200	109.53	18.94	5.78	2.87	REJECT

APPENDIX D

Table 25. Hsu's procedure results for two decision variables for population size = 5

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	10.53	29.03	TRUE	FALSE	51	4.70	19.26	TRUE	FALSE
2	10.88	29.58	TRUE	FALSE	52	4.78	19.18	TRUE	FALSE
3	11.13	29.73	TRUE	FALSE	53	4.78	19.18	TRUE	FALSE
4	11.89	29.91	TRUE	FALSE	54	4.78	19.18	TRUE	FALSE
5	7.93	26.95	TRUE	FALSE	55	4.85	19.23	TRUE	FALSE
6	8.38	27.42	TRUE	FALSE	56	4.85	19.23	TRUE	FALSE
7	7.00	25.60	TRUE	FALSE	57	4.85	19.23	TRUE	FALSE
8	6.86	25.56	TRUE	FALSE	58	4.85	19.23	TRUE	FALSE
9	7.35	25.07	TRUE	FALSE	59	4.85	19.23	TRUE	FALSE
10	7.37	25.05	TRUE	FALSE	60	4.85	19.23	TRUE	FALSE
11	7.37	25.05	TRUE	FALSE	61	4.85	19.23	TRUE	FALSE
12	7.36	25.06	TRUE	FALSE	62	5.01	19.09	TRUE	FALSE
13	7.45	25.15	TRUE	FALSE	63	5.01	19.09	TRUE	FALSE
14	7.53	25.23	TRUE	FALSE	64	5.17	18.93	TRUE	FALSE
15	7.53	25.23	TRUE	FALSE	65	5.18	18.94	TRUE	FALSE
16	8.28	24.88	TRUE	FALSE	66	5.18	18.94	TRUE	FALSE
17	8.28	24.88	TRUE	FALSE	67	5.18	18.94	TRUE	FALSE
18	8.28	24.88	TRUE	FALSE	68	5.18	18.94	TRUE	FALSE
19	8.28	24.88	TRUE	FALSE	69	5.18	18.94	TRUE	FALSE
20	8.28	24.88	TRUE	FALSE	70	4.77	18.45	TRUE	FALSE
21	8.28	24.88	TRUE	FALSE	71	4.77	18.45	TRUE	FALSE
22	8.26	24.90	TRUE	FALSE	72	2.21	14.63	TRUE	FALSE
23	8.35	24.99	TRUE	FALSE	73	2.21	14.63	TRUE	FALSE
24	8.35	24.99	TRUE	FALSE	74	2.21	14.63	TRUE	FALSE
25	8.35	24.99	TRUE	FALSE	75	2.21	14.63	TRUE	FALSE
26	8.35	24.99	TRUE	FALSE	76	2.21	14.63	TRUE	FALSE
27	8.39	24.95	TRUE	FALSE	77	2.21	14.63	TRUE	FALSE
28	8.36	24.72	TRUE	FALSE	78	2.21	14.63	TRUE	FALSE
29	8.47	24.83	TRUE	FALSE	79	2.21	14.63	TRUE	FALSE
30	8.47	24.83	TRUE	FALSE	80	2.21	14.63	TRUE	FALSE
31	8.47	24.83	TRUE	FALSE	81	2.21	14.63	TRUE	FALSE
32	8.45	24.85	TRUE	FALSE	82	2.21	14.63	TRUE	FALSE
33	7.80	22.74	TRUE	FALSE	83	2.21	14.63	TRUE	FALSE
34	7.80	22.74	TRUE	FALSE	84	2.21	14.63	TRUE	FALSE
35	7.80	22.74	TRUE	FALSE	85	2.31	14.71	TRUE	FALSE
36	7.81	22.73	TRUE	FALSE	86	2.31	14.71	TRUE	FALSE
37	7.81	22.73	TRUE	FALSE	87	2.31	14.71	TRUE	FALSE
38	7.81	22.73	TRUE	FALSE	88	2.31	14.71	TRUE	FALSE
39	7.81	22.73	TRUE	FALSE	89	2.31	14.71	TRUE	FALSE
40	7.81	22.73	TRUE	FALSE	90	2.24	12.20	TRUE	FALSE
41	7.81	22.73	TRUE	FALSE	91	2.24	12.20	TRUE	FALSE
42	7.81	22.73	TRUE	FALSE	92	2.24	12.20	TRUE	FALSE
43	7.81	22.73	TRUE	FALSE	93	2.24	12.20	TRUE	FALSE
44	6.42	21.82	TRUE	FALSE	94	2.24	12.20	TRUE	FALSE
45	6.42	21.82	TRUE	FALSE	95	2.24	12.20	TRUE	FALSE
46	6.42	21.82	TRUE	FALSE	96	2.24	12.20	TRUE	FALSE
47	6.42	21.82	TRUE	FALSE	97	2.24	12.20	TRUE	FALSE
48	5.69	20.07	TRUE	FALSE	98	2.23	12.21	TRUE	FALSE
49	4.70	19.26	TRUE	FALSE	99	2.23	12.21	TRUE	FALSE
50	4.70	19.26	TRUE	FALSE	100	2.23	12.21	TRUE	FALSE

Table 26. Hsu's procedure results for two decision variables for population size = 10

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	1.04	19.54	TRUE	FALSE	51	-3.41	11.15	FALSE	FALSE
2	1.39	20.09	TRUE	FALSE	52	-3.65	10.75	FALSE	FALSE
3	1.63	20.23	TRUE	FALSE	53	-3.65	10.75	FALSE	FALSE
4	1.92	19.94	TRUE	FALSE	54	-3.65	10.75	FALSE	FALSE
5	0.35	19.37	TRUE	FALSE	55	-3.58	10.80	FALSE	FALSE
6	0.80	19.84	TRUE	FALSE	56	-3.58	10.80	FALSE	FALSE
7	1.19	19.79	TRUE	FALSE	57	-3.58	10.80	FALSE	FALSE
8	-0.27	18.43	FALSE	FALSE	58	-3.58	10.80	FALSE	FALSE
9	-1.26	16.46	FALSE	FALSE	59	-3.58	10.80	FALSE	FALSE
10	-1.24	16.44	FALSE	FALSE	60	-3.58	10.80	FALSE	FALSE
11	-1.24	16.44	FALSE	FALSE	61	-3.58	10.80	FALSE	FALSE
12	-1.25	16.45	FALSE	FALSE	62	-4.57	9.51	FALSE	FALSE
13	-1.16	16.54	FALSE	FALSE	63	-4.57	9.51	FALSE	FALSE
14	-1.08	16.62	FALSE	FALSE	64	-4.41	9.35	FALSE	FALSE
15	-1.08	16.62	FALSE	FALSE	65	-4.40	9.36	FALSE	FALSE
16	-4.23	12.37	FALSE	FALSE	66	-4.40	9.36	FALSE	FALSE
17	-4.23	12.37	FALSE	FALSE	67	-4.40	9.36	FALSE	FALSE
18	-4.23	12.37	FALSE	FALSE	68	-4.40	9.36	FALSE	FALSE
19	-4.23	12.37	FALSE	FALSE	69	-4.40	9.36	FALSE	FALSE
20	-4.23	12.37	FALSE	FALSE	70	-4.36	9.32	FALSE	FALSE
21	-4.23	12.37	FALSE	FALSE	71	-4.36	9.32	FALSE	FALSE
22	-4.45	12.19	FALSE	FALSE	72	-3.73	8.69	FALSE	FALSE
23	-4.36	12.28	FALSE	FALSE	73	-3.73	8.69	FALSE	FALSE
24	-4.36	12.28	FALSE	FALSE	74	-3.73	8.69	FALSE	FALSE
25	-4.36	12.28	FALSE	FALSE	75	-3.73	8.69	FALSE	FALSE
26	-4.36	12.28	FALSE	FALSE	76	-3.73	8.69	FALSE	FALSE
27	-4.32	12.24	FALSE	FALSE	77	-3.73	8.69	FALSE	FALSE
28	-4.22	12.14	FALSE	FALSE	78	-3.73	8.69	FALSE	FALSE
29	-4.11	12.25	FALSE	FALSE	79	-3.73	8.69	FALSE	FALSE
30	-4.11	12.25	FALSE	FALSE	80	-3.73	8.69	FALSE	FALSE
31	-4.11	12.25	FALSE	FALSE	81	-3.73	8.69	FALSE	FALSE
32	-4.33	12.07	FALSE	FALSE	82	-3.73	8.69	FALSE	FALSE
33	-3.60	11.34	FALSE	FALSE	83	-3.73	8.69	FALSE	FALSE
34	-3.60	11.34	FALSE	FALSE	84	-3.73	8.69	FALSE	FALSE
35	-3.60	11.34	FALSE	FALSE	85	-3.63	8.77	FALSE	FALSE
36	-3.59	11.33	FALSE	FALSE	86	-3.63	8.77	FALSE	FALSE
37	-3.59	11.33	FALSE	FALSE	87	-3.63	8.77	FALSE	FALSE
38	-3.59	11.33	FALSE	FALSE	88	-3.63	8.77	FALSE	FALSE
39	-3.59	11.33	FALSE	FALSE	89	-3.63	8.77	FALSE	FALSE
40	-3.59	11.33	FALSE	FALSE	90	-2.41	7.55	FALSE	FALSE
41	-3.59	11.33	FALSE	FALSE	91	-2.41	7.55	FALSE	FALSE
42	-3.59	11.33	FALSE	FALSE	92	-2.41	7.55	FALSE	FALSE
43	-3.59	11.33	FALSE	FALSE	93	-2.41	7.55	FALSE	FALSE
44	-3.83	11.57	FALSE	FALSE	94	-2.41	7.55	FALSE	FALSE
45	-3.83	11.57	FALSE	FALSE	95	-2.41	7.55	FALSE	FALSE
46	-3.83	11.57	FALSE	FALSE	96	-2.41	7.55	FALSE	FALSE
47	-3.83	11.57	FALSE	FALSE	97	-2.41	7.55	FALSE	FALSE
48	-3.32	11.06	FALSE	FALSE	98	-2.59	7.39	FALSE	FALSE
49	-3.41	11.15	FALSE	FALSE	99	-2.59	7.39	FALSE	FALSE
50	-3.41	11.15	FALSE	FALSE	100	-2.59	7.39	FALSE	FALSE

Table 27. Hsu's procedure results for two decision variables for population size = 20

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-4.04	14.46	FALSE	FALSE	51	-5.74	8.82	FALSE	FALSE
2	-4.62	14.08	FALSE	FALSE	52	-5.66	8.74	FALSE	FALSE
3	-4.37	14.23	FALSE	FALSE	53	-5.66	8.74	FALSE	FALSE
4	-5.67	12.35	FALSE	FALSE	54	-5.66	8.74	FALSE	FALSE
5	-6.92	12.10	FALSE	FALSE	55	-5.59	8.79	FALSE	FALSE
6	-6.67	12.37	FALSE	FALSE	56	-5.59	8.79	FALSE	FALSE
7	-6.28	12.32	FALSE	FALSE	57	-5.59	8.79	FALSE	FALSE
8	-6.33	12.37	FALSE	FALSE	58	-5.59	8.79	FALSE	FALSE
9	-6.27	11.45	FALSE	FALSE	59	-5.59	8.79	FALSE	FALSE
10	-7.02	10.66	FALSE	FALSE	60	-5.59	8.79	FALSE	FALSE
11	-7.10	10.58	FALSE	FALSE	61	-5.59	8.79	FALSE	FALSE
12	-7.11	10.59	FALSE	FALSE	62	-5.52	8.56	FALSE	FALSE
13	-7.02	10.68	FALSE	FALSE	63	-5.52	8.56	FALSE	FALSE
14	-6.94	10.76	FALSE	FALSE	64	-6.20	7.56	FALSE	FALSE
15	-6.94	10.76	FALSE	FALSE	65	-6.19	7.57	FALSE	FALSE
16	-6.19	10.41	FALSE	FALSE	66	-6.19	7.57	FALSE	FALSE
17	-6.19	10.41	FALSE	FALSE	67	-6.19	7.57	FALSE	FALSE
18	-6.19	10.41	FALSE	FALSE	68	-6.19	7.57	FALSE	FALSE
19	-6.19	10.41	FALSE	FALSE	69	-6.19	7.57	FALSE	FALSE
20	-6.19	10.41	FALSE	FALSE	70	-6.15	7.53	FALSE	FALSE
21	-6.19	10.41	FALSE	FALSE	71	-6.15	7.53	FALSE	FALSE
22	-6.21	10.43	FALSE	FALSE	72	-5.52	6.90	FALSE	FALSE
23	-6.12	10.52	FALSE	FALSE	73	-5.52	6.90	FALSE	FALSE
24	-6.12	10.52	FALSE	FALSE	74	-5.52	6.90	FALSE	FALSE
25	-6.12	10.52	FALSE	FALSE	75	-5.52	6.90	FALSE	FALSE
26	-6.12	10.52	FALSE	FALSE	76	-5.52	6.90	FALSE	FALSE
27	-6.84	9.72	FALSE	FALSE	77	-5.52	6.90	FALSE	FALSE
28	-6.74	9.62	FALSE	FALSE	78	-5.52	6.90	FALSE	FALSE
29	-6.63	9.73	FALSE	FALSE	79	-5.52	6.90	FALSE	FALSE
30	-6.63	9.73	FALSE	FALSE	80	-5.52	6.90	FALSE	FALSE
31	-6.63	9.73	FALSE	FALSE	81	-5.52	6.90	FALSE	FALSE
32	-6.66	9.74	FALSE	FALSE	82	-5.52	6.90	FALSE	FALSE
33	-5.93	9.01	FALSE	FALSE	83	-5.52	6.90	FALSE	FALSE
34	-5.93	9.01	FALSE	FALSE	84	-5.52	6.90	FALSE	FALSE
35	-5.93	9.01	FALSE	FALSE	85	-5.50	6.90	FALSE	FALSE
36	-5.92	9.00	FALSE	FALSE	86	-5.50	6.90	FALSE	FALSE
37	-5.92	9.00	FALSE	FALSE	87	-5.58	6.82	FALSE	FALSE
38	-5.92	9.00	FALSE	FALSE	88	-5.58	6.82	FALSE	FALSE
39	-5.92	9.00	FALSE	FALSE	89	-5.58	6.82	FALSE	FALSE
40	-5.92	9.00	FALSE	FALSE	90	-4.36	5.60	FALSE	FALSE
41	-5.92	9.00	FALSE	FALSE	91	-4.36	5.60	FALSE	FALSE
42	-5.92	9.00	FALSE	FALSE	92	-4.36	5.60	FALSE	FALSE
43	-5.92	9.00	FALSE	FALSE	93	-4.36	5.60	FALSE	FALSE
44	-6.16	9.24	FALSE	FALSE	94	-4.36	5.60	FALSE	FALSE
45	-6.16	9.24	FALSE	FALSE	95	-4.36	5.60	FALSE	FALSE
46	-6.16	9.24	FALSE	FALSE	96	-4.36	5.60	FALSE	FALSE
47	-6.16	9.24	FALSE	FALSE	97	-4.36	5.60	FALSE	FALSE
48	-5.65	8.73	FALSE	FALSE	98	-4.37	5.61	FALSE	FALSE
49	-5.74	8.82	FALSE	FALSE	99	-4.37	5.61	FALSE	FALSE
50	-5.74	8.82	FALSE	FALSE	100	-4.37	5.61	FALSE	FALSE

Table 28. Hsu's procedure results for two decision variables for population size = 50

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-7.78	10.72	FALSE	FALSE	51	-7.06	7.50	FALSE	FALSE
2	-7.86	10.84	FALSE	FALSE	52	-6.98	7.42	FALSE	FALSE
3	-9.50	9.10	FALSE	FALSE	53	-6.98	7.42	FALSE	FALSE
4	-9.23	8.79	FALSE	FALSE	54	-7.18	7.22	FALSE	FALSE
5	-9.73	9.29	FALSE	FALSE	55	-7.25	7.13	FALSE	FALSE
6	-9.06	9.98	FALSE	FALSE	56	-7.25	7.13	FALSE	FALSE
7	-8.67	9.93	FALSE	FALSE	57	-7.25	7.13	FALSE	FALSE
8	-8.84	9.86	FALSE	FALSE	58	-7.25	7.13	FALSE	FALSE
9	-8.44	9.28	FALSE	FALSE	59	-7.25	7.13	FALSE	FALSE
10	-8.42	9.26	FALSE	FALSE	60	-7.25	7.13	FALSE	FALSE
11	-8.42	9.26	FALSE	FALSE	61	-7.25	7.13	FALSE	FALSE
12	-8.63	9.07	FALSE	FALSE	62	-7.11	6.97	FALSE	FALSE
13	-8.54	9.16	FALSE	FALSE	63	-7.11	6.97	FALSE	FALSE
14	-8.46	9.24	FALSE	FALSE	64	-6.95	6.81	FALSE	FALSE
15	-8.46	9.24	FALSE	FALSE	65	-6.96	6.80	FALSE	FALSE
16	-7.71	8.89	FALSE	FALSE	66	-6.96	6.80	FALSE	FALSE
17	-7.71	8.89	FALSE	FALSE	67	-6.96	6.80	FALSE	FALSE
18	-7.71	8.89	FALSE	FALSE	68	-6.96	6.80	FALSE	FALSE
19	-7.71	8.89	FALSE	FALSE	69	-6.96	6.80	FALSE	FALSE
20	-7.71	8.89	FALSE	FALSE	70	-6.92	6.76	FALSE	FALSE
21	-7.71	8.89	FALSE	FALSE	71	-6.92	6.76	FALSE	FALSE
22	-7.73	8.91	FALSE	FALSE	72	-6.29	6.13	FALSE	FALSE
23	-7.64	9.00	FALSE	FALSE	73	-6.29	6.13	FALSE	FALSE
24	-7.64	9.00	FALSE	FALSE	74	-6.29	6.13	FALSE	FALSE
25	-7.64	9.00	FALSE	FALSE	75	-6.29	6.13	FALSE	FALSE
26	-7.64	9.00	FALSE	FALSE	76	-6.29	6.13	FALSE	FALSE
27	-7.60	8.96	FALSE	FALSE	77	-6.29	6.13	FALSE	FALSE
28	-7.50	8.86	FALSE	FALSE	78	-6.29	6.13	FALSE	FALSE
29	-7.39	8.97	FALSE	FALSE	79	-6.29	6.13	FALSE	FALSE
30	-7.39	8.97	FALSE	FALSE	80	-6.29	6.13	FALSE	FALSE
31	-7.39	8.97	FALSE	FALSE	81	-6.29	6.13	FALSE	FALSE
32	-7.41	8.99	FALSE	FALSE	82	-6.29	6.13	FALSE	FALSE
33	-6.68	8.26	FALSE	FALSE	83	-6.29	6.13	FALSE	FALSE
34	-6.68	8.26	FALSE	FALSE	84	-6.21	6.21	FALSE	FALSE
35	-6.68	8.26	FALSE	FALSE	85	-6.11	6.29	FALSE	FALSE
36	-6.87	8.05	FALSE	FALSE	86	-6.11	6.29	FALSE	FALSE
37	-6.87	8.05	FALSE	FALSE	87	-6.11	6.29	FALSE	FALSE
38	-6.87	8.05	FALSE	FALSE	88	-6.11	6.29	FALSE	FALSE
39	-6.88	8.04	FALSE	FALSE	89	-6.11	6.29	FALSE	FALSE
40	-7.16	7.76	FALSE	FALSE	90	-4.89	5.07	FALSE	FALSE
41	-7.16	7.76	FALSE	FALSE	91	-4.89	5.07	FALSE	FALSE
42	-7.16	7.76	FALSE	FALSE	92	-4.89	5.07	FALSE	FALSE
43	-7.16	7.76	FALSE	FALSE	93	-4.89	5.07	FALSE	FALSE
44	-7.40	8.00	FALSE	FALSE	94	-4.89	5.07	FALSE	FALSE
45	-7.40	8.00	FALSE	FALSE	95	-4.89	5.07	FALSE	FALSE
46	-7.40	8.00	FALSE	FALSE	96	-4.89	5.07	FALSE	FALSE
47	-7.40	8.00	FALSE	FALSE	97	-4.89	5.07	FALSE	FALSE
48	-6.89	7.49	FALSE	FALSE	98	-4.90	5.08	FALSE	FALSE
49	-6.98	7.58	FALSE	FALSE	99	-4.90	5.08	FALSE	FALSE
50	-6.98	7.58	FALSE	FALSE	100	-4.90	5.08	FALSE	FALSE

Table 29. Hsu's procedure results for two decision variables for population size = 100

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
71	-10.72	7.78	FALSE	FALSE	51	-7.50	7.06	FALSE	FALSE
2	-10.84	7.86	FALSE	FALSE	52	-7.42	6.98	FALSE	FALSE
3	-9.10	9.50	FALSE	FALSE	53	-7.42	6.98	FALSE	FALSE
4	-8.79	9.23	FALSE	FALSE	54	-7.22	7.18	FALSE	FALSE
5	-9.29	9.73	FALSE	FALSE	55	-7.13	7.25	FALSE	FALSE
6	-9.98	9.06	FALSE	FALSE	56	-7.13	7.25	FALSE	FALSE
7	-9.93	8.67	FALSE	FALSE	57	-7.13	7.25	FALSE	FALSE
8	-9.86	8.84	FALSE	FALSE	58	-7.13	7.25	FALSE	FALSE
9	-9.28	8.44	FALSE	FALSE	59	-7.13	7.25	FALSE	FALSE
10	-9.26	8.42	FALSE	FALSE	60	-7.13	7.25	FALSE	FALSE
11	-9.26	8.42	FALSE	FALSE	61	-7.13	7.25	FALSE	FALSE
12	-9.07	8.63	FALSE	FALSE	62	-6.97	7.11	FALSE	FALSE
13	-9.16	8.54	FALSE	FALSE	63	-6.97	7.11	FALSE	FALSE
14	-9.24	8.46	FALSE	FALSE	64	-6.81	6.95	FALSE	FALSE
15	-9.24	8.46	FALSE	FALSE	65	-6.80	6.96	FALSE	FALSE
16	-8.89	7.71	FALSE	FALSE	66	-6.80	6.96	FALSE	FALSE
17	-8.89	7.71	FALSE	FALSE	67	-6.80	6.96	FALSE	FALSE
18	-8.89	7.71	FALSE	FALSE	68	-6.80	6.96	FALSE	FALSE
19	-8.89	7.71	FALSE	FALSE	69	-6.80	6.96	FALSE	FALSE
20	-8.89	7.71	FALSE	FALSE	70	-6.76	6.92	FALSE	FALSE
21	-8.89	7.71	FALSE	FALSE	71	-6.76	6.92	FALSE	FALSE
22	-8.91	7.73	FALSE	FALSE	72	-6.13	6.29	FALSE	FALSE
23	-9.00	7.64	FALSE	FALSE	73	-6.13	6.29	FALSE	FALSE
24	-9.00	7.64	FALSE	FALSE	74	-6.13	6.29	FALSE	FALSE
25	-9.00	7.64	FALSE	FALSE	75	-6.13	6.29	FALSE	FALSE
26	-9.00	7.64	FALSE	FALSE	76	-6.13	6.29	FALSE	FALSE
27	-8.96	7.60	FALSE	FALSE	77	-6.13	6.29	FALSE	FALSE
28	-8.86	7.50	FALSE	FALSE	78	-6.13	6.29	FALSE	FALSE
29	-8.97	7.39	FALSE	FALSE	79	-6.13	6.29	FALSE	FALSE
30	-8.97	7.39	FALSE	FALSE	80	-6.13	6.29	FALSE	FALSE
31	-8.97	7.39	FALSE	FALSE	81	-6.13	6.29	FALSE	FALSE
32	-8.99	7.41	FALSE	FALSE	82	-6.13	6.29	FALSE	FALSE
33	-8.26	6.68	FALSE	FALSE	83	-6.13	6.29	FALSE	FALSE
34	-8.26	6.68	FALSE	FALSE	84	-6.21	6.21	FALSE	FALSE
35	-8.26	6.68	FALSE	FALSE	85	-6.29	6.11	FALSE	FALSE
36	-8.05	6.87	FALSE	FALSE	86	-6.29	6.11	FALSE	FALSE
37	-8.05	6.87	FALSE	FALSE	87	-6.29	6.11	FALSE	FALSE
38	-8.05	6.87	FALSE	FALSE	88	-6.29	6.11	FALSE	FALSE
39	-8.04	6.88	FALSE	FALSE	89	-6.29	6.11	FALSE	FALSE
40	-7.76	7.16	FALSE	FALSE	90	-5.07	4.89	FALSE	FALSE
41	-7.76	7.16	FALSE	FALSE	91	-5.07	4.89	FALSE	FALSE
42	-7.76	7.16	FALSE	FALSE	92	-5.07	4.89	FALSE	FALSE
43	-7.76	7.16	FALSE	FALSE	93	-5.07	4.89	FALSE	FALSE
44	-8.00	7.40	FALSE	FALSE	94	-5.07	4.89	FALSE	FALSE
45	-8.00	7.40	FALSE	FALSE	95	-5.07	4.89	FALSE	FALSE
46	-8.00	7.40	FALSE	FALSE	96	-5.07	4.89	FALSE	FALSE
47	-8.00	7.40	FALSE	FALSE	97	-5.07	4.89	FALSE	FALSE
48	-7.49	6.89	FALSE	FALSE	98	-5.08	4.90	FALSE	FALSE
49	-7.58	6.98	FALSE	FALSE	99	-5.08	4.90	FALSE	FALSE
50	-7.58	6.98	FALSE	FALSE	100	-5.08	4.90	FALSE	FALSE

Table 30. Hsu's procedure results for six decision variables for population size = 5

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	70.37	149.49	TRUE	FALSE	51	53.18	109.26	TRUE	FALSE
2	98.29	170.97	TRUE	FALSE	52	53.40	109.04	TRUE	FALSE
3	83.79	162.25	TRUE	FALSE	53	53.40	109.04	TRUE	FALSE
4	74.16	150.20	TRUE	FALSE	54	53.56	109.00	TRUE	FALSE
5	70.18	150.42	TRUE	FALSE	55	54.13	109.55	TRUE	FALSE
6	70.06	150.24	TRUE	FALSE	56	48.42	96.00	TRUE	FALSE
7	58.84	139.26	TRUE	FALSE	57	48.72	96.26	TRUE	FALSE
8	57.67	139.27	TRUE	FALSE	58	49.07	96.59	TRUE	FALSE
9	58.06	139.48	TRUE	FALSE	59	49.24	96.42	TRUE	FALSE
10	61.87	143.07	TRUE	FALSE	60	48.10	96.02	TRUE	FALSE
11	65.65	146.71	TRUE	FALSE	61	48.51	95.97	TRUE	FALSE
12	68.90	148.76	TRUE	FALSE	62	48.51	95.97	TRUE	FALSE
13	69.84	150.84	TRUE	FALSE	63	46.15	94.71	TRUE	FALSE
14	64.01	145.79	TRUE	FALSE	64	45.40	94.16	TRUE	FALSE
15	70.49	151.19	TRUE	FALSE	65	44.94	94.62	TRUE	FALSE
16	68.89	149.85	TRUE	FALSE	66	44.77	94.79	TRUE	FALSE
17	69.09	148.13	TRUE	FALSE	67	39.36	91.10	TRUE	FALSE
18	68.72	148.82	TRUE	FALSE	68	39.60	91.38	TRUE	FALSE
19	70.32	149.44	TRUE	FALSE	69	35.01	87.75	TRUE	FALSE
20	70.65	149.93	TRUE	FALSE	70	34.39	87.33	TRUE	FALSE
21	70.57	150.57	TRUE	FALSE	71	34.49	87.39	TRUE	FALSE
22	66.90	148.38	TRUE	FALSE	72	34.13	87.21	TRUE	FALSE
23	66.04	147.68	TRUE	FALSE	73	34.37	87.47	TRUE	FALSE
24	60.80	142.08	TRUE	FALSE	74	34.67	87.17	TRUE	FALSE
25	58.18	127.32	TRUE	FALSE	75	32.38	86.32	TRUE	FALSE
26	55.04	121.54	TRUE	FALSE	76	32.34	86.22	TRUE	FALSE
27	55.08	121.50	TRUE	FALSE	77	32.45	86.31	TRUE	FALSE
28	56.34	122.88	TRUE	FALSE	78	32.59	86.33	TRUE	FALSE
29	56.91	122.31	TRUE	FALSE	79	32.59	86.33	TRUE	FALSE
30	56.93	122.29	TRUE	FALSE	80	32.86	86.42	TRUE	FALSE
31	55.84	120.38	TRUE	FALSE	81	33.56	87.12	TRUE	FALSE
32	56.88	120.36	TRUE	FALSE	82	33.61	87.07	TRUE	FALSE
33	57.06	120.46	TRUE	FALSE	83	33.58	86.90	TRUE	FALSE
34	57.00	120.76	TRUE	FALSE	84	33.61	86.87	TRUE	FALSE
35	55.39	118.77	TRUE	FALSE	85	29.11	81.99	TRUE	FALSE
36	55.47	118.69	TRUE	FALSE	86	29.13	81.97	TRUE	FALSE
37	56.02	118.14	TRUE	FALSE	87	29.03	82.07	TRUE	FALSE
38	56.82	118.30	TRUE	FALSE	88	28.76	82.34	TRUE	FALSE
39	57.41	118.87	TRUE	FALSE	89	28.76	82.34	TRUE	FALSE
40	56.60	119.40	TRUE	FALSE	90	28.86	82.24	TRUE	FALSE
41	55.68	118.88	TRUE	FALSE	91	28.83	82.27	TRUE	FALSE
42	50.04	112.90	TRUE	FALSE	92	29.04	82.06	TRUE	FALSE
43	50.37	113.09	TRUE	FALSE	93	29.39	82.43	TRUE	FALSE
44	50.38	113.08	TRUE	FALSE	94	29.56	82.62	TRUE	FALSE
45	51.62	113.06	TRUE	FALSE	95	28.61	81.35	TRUE	FALSE
46	54.63	110.05	TRUE	FALSE	96	28.72	81.24	TRUE	FALSE
47	53.64	109.24	TRUE	FALSE	97	28.78	81.18	TRUE	FALSE
48	53.56	109.32	TRUE	FALSE	98	28.78	81.18	TRUE	FALSE
49	53.55	108.89	TRUE	FALSE	99	29.38	80.10	TRUE	FALSE
50	53.18	109.26	TRUE	FALSE	100	28.79	77.77	TRUE	FALSE

Table 31. Hsu's procedure results for six decision variables for population size = 10

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	33.06	112.18	TRUE	FALSE	51	13.28	69.36	TRUE	FALSE
2	57.83	130.51	TRUE	FALSE	52	12.73	68.37	TRUE	FALSE
3	21.78	100.24	TRUE	FALSE	53	12.73	68.37	TRUE	FALSE
4	25.25	101.29	TRUE	FALSE	54	12.69	68.13	TRUE	FALSE
5	30.34	110.58	TRUE	FALSE	55	13.26	68.68	TRUE	FALSE
6	27.73	107.91	TRUE	FALSE	56	16.30	63.88	TRUE	FALSE
7	26.07	106.49	TRUE	FALSE	57	16.18	63.72	TRUE	FALSE
8	18.71	100.31	TRUE	FALSE	58	16.53	64.05	TRUE	FALSE
9	18.28	99.70	TRUE	FALSE	59	15.31	62.49	TRUE	FALSE
10	20.90	102.10	TRUE	FALSE	60	15.04	62.96	TRUE	FALSE
11	23.28	104.34	TRUE	FALSE	61	15.45	62.91	TRUE	FALSE
12	25.97	105.83	TRUE	FALSE	62	15.43	62.89	TRUE	FALSE
13	24.18	105.18	TRUE	FALSE	63	14.88	63.44	TRUE	FALSE
14	25.29	107.07	TRUE	FALSE	64	13.71	62.47	TRUE	FALSE
15	29.15	109.85	TRUE	FALSE	65	13.25	62.93	TRUE	FALSE
16	27.35	108.31	TRUE	FALSE	66	11.58	61.60	TRUE	FALSE
17	28.14	107.18	TRUE	FALSE	67	10.72	62.46	TRUE	FALSE
18	23.98	104.08	TRUE	FALSE	68	10.96	62.74	TRUE	FALSE
19	24.06	103.18	TRUE	FALSE	69	7.87	60.61	TRUE	FALSE
20	24.90	104.18	TRUE	FALSE	70	7.37	60.31	TRUE	FALSE
21	25.62	105.62	TRUE	FALSE	71	7.47	60.37	TRUE	FALSE
22	23.70	105.18	TRUE	FALSE	72	7.38	60.46	TRUE	FALSE
23	23.69	105.33	TRUE	FALSE	73	7.62	60.72	TRUE	FALSE
24	22.28	103.56	TRUE	FALSE	74	7.92	60.42	TRUE	FALSE
25	28.35	97.49	TRUE	FALSE	75	7.20	61.14	TRUE	FALSE
26	29.67	96.17	TRUE	FALSE	76	7.02	60.90	TRUE	FALSE
27	29.51	95.93	TRUE	FALSE	77	7.13	60.99	TRUE	FALSE
28	30.77	97.31	TRUE	FALSE	78	7.02	60.76	TRUE	FALSE
29	28.76	94.16	TRUE	FALSE	79	7.02	60.76	TRUE	FALSE
30	28.78	94.14	TRUE	FALSE	80	7.29	60.85	TRUE	FALSE
31	29.19	93.73	TRUE	FALSE	81	7.70	61.26	TRUE	FALSE
32	30.46	93.94	TRUE	FALSE	82	7.75	61.21	TRUE	FALSE
33	26.30	89.70	TRUE	FALSE	83	7.86	61.18	TRUE	FALSE
34	24.36	88.12	TRUE	FALSE	84	7.89	61.15	TRUE	FALSE
35	24.55	87.93	TRUE	FALSE	85	8.29	61.17	TRUE	FALSE
36	24.63	87.85	TRUE	FALSE	86	8.31	61.15	TRUE	FALSE
37	24.53	86.65	TRUE	FALSE	87	8.04	61.08	TRUE	FALSE
38	24.47	85.95	TRUE	FALSE	88	6.81	60.39	TRUE	FALSE
39	25.71	87.17	TRUE	FALSE	89	6.81	60.39	TRUE	FALSE
40	23.38	86.18	TRUE	FALSE	90	6.91	60.29	TRUE	FALSE
41	23.18	86.38	TRUE	FALSE	91	6.88	60.32	TRUE	FALSE
42	23.35	86.21	TRUE	FALSE	92	6.50	59.52	TRUE	FALSE
43	23.68	86.40	TRUE	FALSE	93	6.85	59.89	TRUE	FALSE
44	23.69	86.39	TRUE	FALSE	94	7.02	60.08	TRUE	FALSE
45	22.60	84.04	TRUE	FALSE	95	7.18	59.92	TRUE	FALSE
46	15.57	70.99	TRUE	FALSE	96	5.98	58.50	TRUE	FALSE
47	15.48	71.08	TRUE	FALSE	97	6.04	58.44	TRUE	FALSE
48	15.40	71.16	TRUE	FALSE	98	6.04	58.44	TRUE	FALSE
49	13.78	69.12	TRUE	FALSE	99	3.57	54.29	TRUE	FALSE
50	13.28	69.36	TRUE	FALSE	100	4.44	53.42	TRUE	FALSE

Table 32. Hsu's procedure results for six decision variables for population size = 20

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-0.85	78.27	FALSE	FALSE	51	9.57	65.65	TRUE	FALSE
2	13.26	85.94	TRUE	FALSE	52	9.79	65.43	TRUE	FALSE
3	0.58	79.04	TRUE	FALSE	53	9.79	65.43	TRUE	FALSE
4	-0.30	75.74	FALSE	FALSE	54	9.24	64.68	TRUE	FALSE
5	1.34	81.58	TRUE	FALSE	55	9.81	65.23	TRUE	FALSE
6	0.69	80.87	TRUE	FALSE	56	13.73	61.31	TRUE	FALSE
7	0.96	81.38	TRUE	FALSE	57	14.03	61.57	TRUE	FALSE
8	1.35	82.95	TRUE	FALSE	58	13.44	60.96	TRUE	FALSE
9	-2.52	78.90	FALSE	FALSE	59	12.02	59.20	TRUE	FALSE
10	-0.53	80.67	FALSE	FALSE	60	11.75	59.67	TRUE	FALSE
11	3.79	84.85	TRUE	FALSE	61	11.08	58.54	TRUE	FALSE
12	3.83	83.69	TRUE	FALSE	62	11.08	58.54	TRUE	FALSE
13	4.60	85.60	TRUE	FALSE	63	9.60	58.16	TRUE	FALSE
14	2.56	84.34	TRUE	FALSE	64	9.37	58.13	TRUE	FALSE
15	13.52	94.22	TRUE	FALSE	65	5.48	55.16	TRUE	FALSE
16	13.13	94.09	TRUE	FALSE	66	5.31	55.33	TRUE	FALSE
17	8.45	87.49	TRUE	FALSE	67	4.45	56.19	TRUE	FALSE
18	7.51	87.61	TRUE	FALSE	68	4.37	56.15	TRUE	FALSE
19	9.74	88.86	TRUE	FALSE	69	3.89	56.63	TRUE	FALSE
20	9.12	88.40	TRUE	FALSE	70	3.61	56.55	TRUE	FALSE
21	8.27	88.27	TRUE	FALSE	71	3.71	56.61	TRUE	FALSE
22	7.04	88.52	TRUE	FALSE	72	2.12	55.20	TRUE	FALSE
23	7.09	88.73	TRUE	FALSE	73	2.36	55.46	TRUE	FALSE
24	5.77	87.05	TRUE	FALSE	74	1.51	54.01	TRUE	FALSE
25	11.29	80.43	TRUE	FALSE	75	0.79	54.73	TRUE	FALSE
26	12.31	78.81	TRUE	FALSE	76	0.84	54.72	TRUE	FALSE
27	11.51	77.93	TRUE	FALSE	77	0.95	54.81	TRUE	FALSE
28	12.77	79.31	TRUE	FALSE	78	0.53	54.27	TRUE	FALSE
29	13.34	78.74	TRUE	FALSE	79	0.53	54.27	TRUE	FALSE
30	12.63	77.99	TRUE	FALSE	80	0.12	53.68	TRUE	FALSE
31	12.54	77.08	TRUE	FALSE	81	0.67	54.23	TRUE	FALSE
32	13.53	77.01	TRUE	FALSE	82	0.72	54.18	TRUE	FALSE
33	13.71	77.11	TRUE	FALSE	83	-0.09	53.23	FALSE	FALSE
34	12.89	76.65	TRUE	FALSE	84	-0.21	53.05	FALSE	FALSE
35	12.77	76.15	TRUE	FALSE	85	0.19	53.07	TRUE	FALSE
36	12.85	76.07	TRUE	FALSE	86	0.21	53.05	TRUE	FALSE
37	13.17	75.29	TRUE	FALSE	87	-1.15	51.89	FALSE	FALSE
38	13.84	75.32	TRUE	FALSE	88	-1.42	52.16	FALSE	FALSE
39	15.08	76.54	TRUE	FALSE	89	-1.56	52.02	FALSE	FALSE
40	15.17	77.97	TRUE	FALSE	90	-1.99	51.39	FALSE	FALSE
41	14.81	78.01	TRUE	FALSE	91	-3.78	49.66	FALSE	FALSE
42	11.39	74.25	TRUE	FALSE	92	-3.83	49.19	FALSE	FALSE
43	11.55	74.27	TRUE	FALSE	93	-3.77	49.27	FALSE	FALSE
44	11.56	74.26	TRUE	FALSE	94	-3.71	49.35	FALSE	FALSE
45	12.80	74.24	TRUE	FALSE	95	-4.60	48.14	FALSE	FALSE
46	14.56	69.98	TRUE	FALSE	96	-4.53	47.99	FALSE	FALSE
47	14.21	69.81	TRUE	FALSE	97	-4.80	47.60	FALSE	FALSE
48	12.92	68.68	TRUE	FALSE	98	-4.80	47.60	FALSE	FALSE
49	12.89	68.23	TRUE	FALSE	99	-3.96	46.76	FALSE	FALSE
50	9.57	65.65	TRUE	FALSE	100	-3.09	45.89	FALSE	FALSE

Table 33. Hsu's procedure results for six decision variables for population size = 50

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-20.18	58.94	FALSE	FALSE	51	-11.03	45.05	FALSE	FALSE
2	1.61	74.29	TRUE	FALSE	52	-12.18	43.46	FALSE	FALSE
3	-1.00	77.46	FALSE	FALSE	53	-12.18	43.46	FALSE	FALSE
4	-7.73	68.31	FALSE	FALSE	54	-12.19	43.25	FALSE	FALSE
5	-13.40	66.84	FALSE	FALSE	55	-11.64	43.78	FALSE	FALSE
6	-9.22	70.96	FALSE	FALSE	56	-7.72	39.86	FALSE	FALSE
7	-18.41	62.01	FALSE	FALSE	57	-8.32	39.22	FALSE	FALSE
8	-20.28	61.32	FALSE	FALSE	58	-7.97	39.55	FALSE	FALSE
9	-20.46	60.96	FALSE	FALSE	59	-8.48	38.70	FALSE	FALSE
10	-18.20	63.00	FALSE	FALSE	60	-8.83	39.09	FALSE	FALSE
11	-17.46	63.60	FALSE	FALSE	61	-9.54	37.92	FALSE	FALSE
12	-14.16	65.70	FALSE	FALSE	62	-10.49	36.97	FALSE	FALSE
13	-13.22	67.78	FALSE	FALSE	63	-11.04	37.52	FALSE	FALSE
14	-18.67	63.11	FALSE	FALSE	64	-12.14	36.62	FALSE	FALSE
15	-8.51	72.19	FALSE	FALSE	65	-12.98	36.70	FALSE	FALSE
16	-10.88	70.08	FALSE	FALSE	66	-13.44	36.58	FALSE	FALSE
17	-10.10	68.94	FALSE	FALSE	67	-14.35	37.39	FALSE	FALSE
18	-12.44	67.66	FALSE	FALSE	68	-14.22	37.56	FALSE	FALSE
19	-10.11	69.01	FALSE	FALSE	69	-14.70	38.04	FALSE	FALSE
20	-9.27	70.01	FALSE	FALSE	70	-14.80	38.14	FALSE	FALSE
21	-9.51	70.49	FALSE	FALSE	71	-15.22	37.68	FALSE	FALSE
22	-11.18	70.30	FALSE	FALSE	72	-15.31	37.77	FALSE	FALSE
23	-10.94	70.70	FALSE	FALSE	73	-15.79	37.31	FALSE	FALSE
24	-10.98	70.30	FALSE	FALSE	74	-15.49	37.01	FALSE	FALSE
25	-5.40	63.74	FALSE	FALSE	75	-16.55	37.39	FALSE	FALSE
26	-4.08	62.42	FALSE	FALSE	76	-16.81	37.07	FALSE	FALSE
27	-4.70	61.72	FALSE	FALSE	77	-16.70	37.16	FALSE	FALSE
28	-3.65	62.89	FALSE	FALSE	78	-16.97	36.77	FALSE	FALSE
29	-3.30	62.10	FALSE	FALSE	79	-16.97	36.77	FALSE	FALSE
30	-3.28	62.08	FALSE	FALSE	80	-16.70	36.86	FALSE	FALSE
31	-2.91	61.63	FALSE	FALSE	81	-16.32	37.24	FALSE	FALSE
32	-2.41	61.07	FALSE	FALSE	82	-16.69	36.77	FALSE	FALSE
33	-2.82	60.58	FALSE	FALSE	83	-16.58	36.74	FALSE	FALSE
34	-3.18	60.58	FALSE	FALSE	84	-16.55	36.71	FALSE	FALSE
35	-3.01	60.37	FALSE	FALSE	85	-16.31	36.57	FALSE	FALSE
36	-5.30	57.92	FALSE	FALSE	86	-16.84	36.00	FALSE	FALSE
37	-5.70	56.42	FALSE	FALSE	87	-17.49	35.55	FALSE	FALSE
38	-5.02	56.46	FALSE	FALSE	88	-17.76	35.82	FALSE	FALSE
39	-3.78	57.68	FALSE	FALSE	89	-17.76	35.82	FALSE	FALSE
40	-5.20	57.60	FALSE	FALSE	90	-17.66	35.72	FALSE	FALSE
41	-5.99	57.21	FALSE	FALSE	91	-17.69	35.75	FALSE	FALSE
42	-5.82	57.04	FALSE	FALSE	92	-17.92	35.10	FALSE	FALSE
43	-7.13	55.59	FALSE	FALSE	93	-17.57	35.47	FALSE	FALSE
44	-7.60	55.10	FALSE	FALSE	94	-18.10	34.96	FALSE	FALSE
45	-8.56	52.88	FALSE	FALSE	95	-18.02	34.72	FALSE	FALSE
46	-6.74	48.68	FALSE	FALSE	96	-17.91	34.61	FALSE	FALSE
47	-8.26	47.34	FALSE	FALSE	97	-18.37	34.03	FALSE	FALSE
48	-9.94	45.82	FALSE	FALSE	98	-18.37	34.03	FALSE	FALSE
49	-10.03	45.31	FALSE	FALSE	99	-17.94	32.78	FALSE	FALSE
50	-11.03	45.05	FALSE	FALSE	100	-17.66	31.32	FALSE	FALSE

Table 34. Hsu's procedure results for six decision variables for population size = 100

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-58.94	20.18	FALSE	FALSE	51	-45.05	11.03	FALSE	FALSE
2	-74.29	-1.61	FALSE	TRUE	52	-43.46	12.18	FALSE	FALSE
3	-77.46	1.00	FALSE	FALSE	53	-43.46	12.18	FALSE	FALSE
4	-68.31	7.73	FALSE	FALSE	54	-43.25	12.19	FALSE	FALSE
5	-66.84	13.40	FALSE	FALSE	55	-43.78	11.64	FALSE	FALSE
6	-70.96	9.22	FALSE	FALSE	56	-39.86	7.72	FALSE	FALSE
7	-62.01	18.41	FALSE	FALSE	57	-39.22	8.32	FALSE	FALSE
8	-61.32	20.28	FALSE	FALSE	58	-39.55	7.97	FALSE	FALSE
9	-60.96	20.46	FALSE	FALSE	59	-38.70	8.48	FALSE	FALSE
10	-63.00	18.20	FALSE	FALSE	60	-39.09	8.83	FALSE	FALSE
11	-63.60	17.46	FALSE	FALSE	61	-37.92	9.54	FALSE	FALSE
12	-65.70	14.16	FALSE	FALSE	62	-36.97	10.49	FALSE	FALSE
13	-67.78	13.22	FALSE	FALSE	63	-37.52	11.04	FALSE	FALSE
14	-63.11	18.67	FALSE	FALSE	64	-36.62	12.14	FALSE	FALSE
15	-72.19	8.51	FALSE	FALSE	65	-36.70	12.98	FALSE	FALSE
16	-70.08	10.88	FALSE	FALSE	66	-36.58	13.44	FALSE	FALSE
17	-68.94	10.10	FALSE	FALSE	67	-37.39	14.35	FALSE	FALSE
18	-67.66	12.44	FALSE	FALSE	68	-37.56	14.22	FALSE	FALSE
19	-69.01	10.11	FALSE	FALSE	69	-38.04	14.70	FALSE	FALSE
20	-70.01	9.27	FALSE	FALSE	70	-38.14	14.80	FALSE	FALSE
21	-70.49	9.51	FALSE	FALSE	71	-37.68	15.22	FALSE	FALSE
22	-70.30	11.18	FALSE	FALSE	72	-37.77	15.31	FALSE	FALSE
23	-70.70	10.94	FALSE	FALSE	73	-37.31	15.79	FALSE	FALSE
24	-70.30	10.98	FALSE	FALSE	74	-37.01	15.49	FALSE	FALSE
25	-63.74	5.40	FALSE	FALSE	75	-37.39	16.55	FALSE	FALSE
26	-62.42	4.08	FALSE	FALSE	76	-37.07	16.81	FALSE	FALSE
27	-61.72	4.70	FALSE	FALSE	77	-37.16	16.70	FALSE	FALSE
28	-62.89	3.65	FALSE	FALSE	78	-36.77	16.97	FALSE	FALSE
29	-62.10	3.30	FALSE	FALSE	79	-36.77	16.97	FALSE	FALSE
30	-62.08	3.28	FALSE	FALSE	80	-36.86	16.70	FALSE	FALSE
31	-61.63	2.91	FALSE	FALSE	81	-37.24	16.32	FALSE	FALSE
32	-61.07	2.41	FALSE	FALSE	82	-36.77	16.69	FALSE	FALSE
33	-60.58	2.82	FALSE	FALSE	83	-36.74	16.58	FALSE	FALSE
34	-60.58	3.18	FALSE	FALSE	84	-36.71	16.55	FALSE	FALSE
35	-60.37	3.01	FALSE	FALSE	85	-36.57	16.31	FALSE	FALSE
36	-57.92	5.30	FALSE	FALSE	86	-36.00	16.84	FALSE	FALSE
37	-56.42	5.70	FALSE	FALSE	87	-35.55	17.49	FALSE	FALSE
38	-56.46	5.02	FALSE	FALSE	88	-35.82	17.76	FALSE	FALSE
39	-57.68	3.78	FALSE	FALSE	89	-35.82	17.76	FALSE	FALSE
40	-57.60	5.20	FALSE	FALSE	90	-35.72	17.66	FALSE	FALSE
41	-57.21	5.99	FALSE	FALSE	91	-35.75	17.69	FALSE	FALSE
42	-57.04	5.82	FALSE	FALSE	92	-35.10	17.92	FALSE	FALSE
43	-55.59	7.13	FALSE	FALSE	93	-35.47	17.57	FALSE	FALSE
44	-55.10	7.60	FALSE	FALSE	94	-34.96	18.10	FALSE	FALSE
45	-52.88	8.56	FALSE	FALSE	95	-34.72	18.02	FALSE	FALSE
46	-48.68	6.74	FALSE	FALSE	96	-34.61	17.91	FALSE	FALSE
47	-47.34	8.26	FALSE	FALSE	97	-34.03	18.37	FALSE	FALSE
48	-45.82	9.94	FALSE	FALSE	98	-34.03	18.37	FALSE	FALSE
49	-45.31	10.03	FALSE	FALSE	99	-32.78	17.94	FALSE	FALSE
50	-45.05	11.03	FALSE	FALSE	100	-31.32	17.66	FALSE	FALSE

Table 35. Hsu's procedure results for two decision variables for crossover rate = 0.3

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.54	1.34	FALSE	FALSE
2	-2.45	3.41	FALSE	FALSE	52	-0.54	1.34	FALSE	FALSE
3	-1.23	4.43	FALSE	FALSE	53	-0.54	1.34	FALSE	FALSE
4	-0.80	4.44	FALSE	FALSE	54	-0.56	1.30	FALSE	FALSE
5	0.03	5.11	TRUE	FALSE	55	-0.56	1.30	FALSE	FALSE
6	-0.22	5.00	FALSE	FALSE	56	-0.56	1.30	FALSE	FALSE
7	-0.21	4.53	FALSE	FALSE	57	-0.56	1.30	FALSE	FALSE
8	0.10	3.98	TRUE	FALSE	58	-0.56	1.30	FALSE	FALSE
9	-0.15	3.49	FALSE	FALSE	59	-0.56	1.30	FALSE	FALSE
10	0.05	3.65	TRUE	FALSE	60	-0.56	1.30	FALSE	FALSE
11	0.05	3.65	TRUE	FALSE	61	-0.38	1.40	FALSE	FALSE
12	0.08	3.62	TRUE	FALSE	62	-0.56	1.22	FALSE	FALSE
13	-0.82	2.38	FALSE	FALSE	63	-0.57	1.23	FALSE	FALSE
14	-1.03	1.53	FALSE	FALSE	64	-0.57	1.23	FALSE	FALSE
15	-0.98	1.48	FALSE	FALSE	65	-0.55	1.23	FALSE	FALSE
16	-0.98	1.48	FALSE	FALSE	66	-0.55	1.23	FALSE	FALSE
17	-0.98	1.48	FALSE	FALSE	67	-0.54	1.22	FALSE	FALSE
18	-0.98	1.48	FALSE	FALSE	68	-0.54	1.22	FALSE	FALSE
19	-0.98	1.48	FALSE	FALSE	69	-0.54	1.22	FALSE	FALSE
20	-0.98	1.48	FALSE	FALSE	70	-0.54	1.22	FALSE	FALSE
21	-0.98	1.48	FALSE	FALSE	71	-0.71	1.05	FALSE	FALSE
22	-0.97	1.49	FALSE	FALSE	72	-0.71	1.05	FALSE	FALSE
23	-1.07	1.43	FALSE	FALSE	73	-0.71	1.05	FALSE	FALSE
24	-1.07	1.43	FALSE	FALSE	74	-0.71	1.05	FALSE	FALSE
25	-1.07	1.43	FALSE	FALSE	75	-0.71	1.05	FALSE	FALSE
26	-1.07	1.43	FALSE	FALSE	76	-0.71	1.05	FALSE	FALSE
27	-1.07	1.43	FALSE	FALSE	77	-0.71	1.05	FALSE	FALSE
28	-1.07	1.43	FALSE	FALSE	78	-0.71	1.05	FALSE	FALSE
29	-1.07	1.43	FALSE	FALSE	79	-0.71	1.05	FALSE	FALSE
30	-1.07	1.43	FALSE	FALSE	80	-0.71	1.05	FALSE	FALSE
31	-1.07	1.43	FALSE	FALSE	81	-0.71	1.05	FALSE	FALSE
32	-1.07	1.43	FALSE	FALSE	82	-0.71	1.05	FALSE	FALSE
33	-1.07	1.43	FALSE	FALSE	83	-0.69	1.03	FALSE	FALSE
34	-1.07	1.43	FALSE	FALSE	84	-0.69	1.03	FALSE	FALSE
35	-1.06	1.42	FALSE	FALSE	85	-0.69	1.03	FALSE	FALSE
36	-0.94	1.38	FALSE	FALSE	86	-0.69	1.03	FALSE	FALSE
37	-0.69	1.19	FALSE	FALSE	87	-0.69	1.03	FALSE	FALSE
38	-0.69	1.19	FALSE	FALSE	88	-0.69	1.03	FALSE	FALSE
39	-0.56	1.34	FALSE	FALSE	89	-0.68	1.04	FALSE	FALSE
40	-0.56	1.34	FALSE	FALSE	90	-0.68	1.04	FALSE	FALSE
41	-0.56	1.34	FALSE	FALSE	91	-0.68	1.04	FALSE	FALSE
42	-0.60	1.30	FALSE	FALSE	92	-0.68	1.04	FALSE	FALSE
43	-0.60	1.30	FALSE	FALSE	93	-0.68	1.04	FALSE	FALSE
44	-0.62	1.32	FALSE	FALSE	94	-0.68	1.04	FALSE	FALSE
45	-0.62	1.32	FALSE	FALSE	95	-0.68	1.04	FALSE	FALSE
46	-0.62	1.32	FALSE	FALSE	96	-0.68	1.04	FALSE	FALSE
47	-0.62	1.32	FALSE	FALSE	97	-0.68	1.04	FALSE	FALSE
48	-0.55	1.35	FALSE	FALSE	98	-0.68	1.04	FALSE	FALSE
49	-0.55	1.35	FALSE	FALSE	99	-0.68	1.04	FALSE	FALSE
50	-0.55	1.35	FALSE	FALSE	100	-0.68	1.04	FALSE	FALSE

Table 36. Hsu's procedure results for two decision variables for crossover rate = 0.5

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.75	1.13	FALSE	FALSE
2	-2.45	3.41	FALSE	FALSE	52	-0.75	1.13	FALSE	FALSE
3	-2.22	3.44	FALSE	FALSE	53	-0.75	1.13	FALSE	FALSE
4	-2.56	2.68	FALSE	FALSE	54	-0.74	1.12	FALSE	FALSE
5	-1.71	3.37	FALSE	FALSE	55	-0.74	1.12	FALSE	FALSE
6	-2.01	3.21	FALSE	FALSE	56	-0.74	1.12	FALSE	FALSE
7	-1.97	2.77	FALSE	FALSE	57	-0.74	1.12	FALSE	FALSE
8	-0.96	2.92	FALSE	FALSE	58	-0.74	1.12	FALSE	FALSE
9	-1.34	2.30	FALSE	FALSE	59	-0.74	1.12	FALSE	FALSE
10	-1.34	2.26	FALSE	FALSE	60	-0.74	1.12	FALSE	FALSE
11	-1.34	2.26	FALSE	FALSE	61	-0.56	1.22	FALSE	FALSE
12	-1.31	2.23	FALSE	FALSE	62	-0.56	1.22	FALSE	FALSE
13	-1.14	2.06	FALSE	FALSE	63	-0.60	1.20	FALSE	FALSE
14	-0.82	1.74	FALSE	FALSE	64	-0.60	1.20	FALSE	FALSE
15	-0.87	1.59	FALSE	FALSE	65	-0.56	1.22	FALSE	FALSE
16	-0.87	1.59	FALSE	FALSE	66	-0.56	1.22	FALSE	FALSE
17	-0.87	1.59	FALSE	FALSE	67	-0.55	1.21	FALSE	FALSE
18	-0.87	1.59	FALSE	FALSE	68	-0.55	1.21	FALSE	FALSE
19	-0.87	1.59	FALSE	FALSE	69	-0.55	1.21	FALSE	FALSE
20	-0.87	1.59	FALSE	FALSE	70	-0.55	1.21	FALSE	FALSE
21	-0.87	1.59	FALSE	FALSE	71	-0.57	1.19	FALSE	FALSE
22	-0.86	1.60	FALSE	FALSE	72	-0.57	1.19	FALSE	FALSE
23	-1.08	1.42	FALSE	FALSE	73	-0.57	1.19	FALSE	FALSE
24	-1.08	1.42	FALSE	FALSE	74	-0.57	1.19	FALSE	FALSE
25	-1.08	1.42	FALSE	FALSE	75	-0.57	1.19	FALSE	FALSE
26	-1.08	1.42	FALSE	FALSE	76	-0.57	1.19	FALSE	FALSE
27	-1.08	1.42	FALSE	FALSE	77	-0.57	1.19	FALSE	FALSE
28	-1.08	1.42	FALSE	FALSE	78	-0.57	1.19	FALSE	FALSE
29	-1.08	1.42	FALSE	FALSE	79	-0.57	1.19	FALSE	FALSE
30	-1.08	1.42	FALSE	FALSE	80	-0.57	1.19	FALSE	FALSE
31	-1.08	1.42	FALSE	FALSE	81	-0.57	1.19	FALSE	FALSE
32	-1.08	1.42	FALSE	FALSE	82	-0.57	1.19	FALSE	FALSE
33	-1.08	1.42	FALSE	FALSE	83	-0.55	1.17	FALSE	FALSE
34	-1.08	1.42	FALSE	FALSE	84	-0.55	1.17	FALSE	FALSE
35	-1.12	1.36	FALSE	FALSE	85	-0.55	1.17	FALSE	FALSE
36	-1.00	1.32	FALSE	FALSE	86	-0.55	1.17	FALSE	FALSE
37	-0.97	0.91	FALSE	FALSE	87	-0.55	1.17	FALSE	FALSE
38	-0.97	0.91	FALSE	FALSE	88	-0.55	1.17	FALSE	FALSE
39	-0.81	1.09	FALSE	FALSE	89	-0.55	1.17	FALSE	FALSE
40	-0.81	1.09	FALSE	FALSE	90	-0.55	1.17	FALSE	FALSE
41	-0.81	1.09	FALSE	FALSE	91	-0.55	1.17	FALSE	FALSE
42	-0.81	1.09	FALSE	FALSE	92	-0.55	1.17	FALSE	FALSE
43	-0.81	1.09	FALSE	FALSE	93	-0.55	1.17	FALSE	FALSE
44	-0.83	1.11	FALSE	FALSE	94	-0.55	1.17	FALSE	FALSE
45	-0.83	1.11	FALSE	FALSE	95	-0.55	1.17	FALSE	FALSE
46	-0.83	1.11	FALSE	FALSE	96	-0.55	1.17	FALSE	FALSE
47	-0.83	1.11	FALSE	FALSE	97	-0.55	1.17	FALSE	FALSE
48	-0.76	1.14	FALSE	FALSE	98	-0.55	1.17	FALSE	FALSE
49	-0.76	1.14	FALSE	FALSE	99	-0.55	1.17	FALSE	FALSE
50	-0.76	1.14	FALSE	FALSE	100	-0.55	1.17	FALSE	FALSE

Table 37. Hsu's procedure results for two decision variables for crossover rate = 0.7

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.99	0.89	FALSE	FALSE
2	-2.97	2.89	FALSE	FALSE	52	-0.99	0.89	FALSE	FALSE
3	-2.03	3.63	FALSE	FALSE	53	-0.99	0.89	FALSE	FALSE
4	-2.12	3.12	FALSE	FALSE	54	-0.98	0.88	FALSE	FALSE
5	-1.66	3.42	FALSE	FALSE	55	-0.98	0.88	FALSE	FALSE
6	-1.86	3.36	FALSE	FALSE	56	-0.98	0.88	FALSE	FALSE
7	-2.10	2.64	FALSE	FALSE	57	-0.98	0.88	FALSE	FALSE
8	-1.09	2.79	FALSE	FALSE	58	-0.98	0.88	FALSE	FALSE
9	-0.97	2.67	FALSE	FALSE	59	-0.98	0.88	FALSE	FALSE
10	-0.97	2.63	FALSE	FALSE	60	-0.98	0.88	FALSE	FALSE
11	-1.26	2.34	FALSE	FALSE	61	-0.75	1.03	FALSE	FALSE
12	-1.33	2.21	FALSE	FALSE	62	-0.75	1.03	FALSE	FALSE
13	-1.20	2.00	FALSE	FALSE	63	-0.79	1.01	FALSE	FALSE
14	-0.88	1.68	FALSE	FALSE	64	-0.79	1.01	FALSE	FALSE
15	-0.83	1.63	FALSE	FALSE	65	-0.75	1.03	FALSE	FALSE
16	-0.83	1.63	FALSE	FALSE	66	-0.75	1.03	FALSE	FALSE
17	-0.83	1.63	FALSE	FALSE	67	-0.84	0.92	FALSE	FALSE
18	-0.83	1.63	FALSE	FALSE	68	-0.84	0.92	FALSE	FALSE
19	-0.83	1.63	FALSE	FALSE	69	-0.84	0.92	FALSE	FALSE
20	-0.83	1.63	FALSE	FALSE	70	-0.84	0.92	FALSE	FALSE
21	-0.83	1.63	FALSE	FALSE	71	-0.84	0.92	FALSE	FALSE
22	-0.82	1.64	FALSE	FALSE	72	-0.84	0.92	FALSE	FALSE
23	-1.04	1.46	FALSE	FALSE	73	-0.84	0.92	FALSE	FALSE
24	-1.04	1.46	FALSE	FALSE	74	-0.84	0.92	FALSE	FALSE
25	-1.04	1.46	FALSE	FALSE	75	-0.84	0.92	FALSE	FALSE
26	-1.04	1.46	FALSE	FALSE	76	-0.84	0.92	FALSE	FALSE
27	-1.04	1.46	FALSE	FALSE	77	-0.84	0.92	FALSE	FALSE
28	-1.04	1.46	FALSE	FALSE	78	-0.84	0.92	FALSE	FALSE
29	-1.04	1.46	FALSE	FALSE	79	-0.84	0.92	FALSE	FALSE
30	-1.04	1.46	FALSE	FALSE	80	-0.84	0.92	FALSE	FALSE
31	-1.04	1.46	FALSE	FALSE	81	-0.84	0.92	FALSE	FALSE
32	-1.04	1.46	FALSE	FALSE	82	-0.84	0.92	FALSE	FALSE
33	-1.04	1.46	FALSE	FALSE	83	-0.86	0.86	FALSE	FALSE
34	-1.04	1.46	FALSE	FALSE	84	-0.86	0.86	FALSE	FALSE
35	-1.10	1.38	FALSE	FALSE	85	-0.86	0.86	FALSE	FALSE
36	-1.20	1.12	FALSE	FALSE	86	-0.86	0.86	FALSE	FALSE
37	-0.91	0.97	FALSE	FALSE	87	-0.86	0.86	FALSE	FALSE
38	-0.91	0.97	FALSE	FALSE	88	-0.86	0.86	FALSE	FALSE
39	-1.09	0.81	FALSE	FALSE	89	-0.86	0.86	FALSE	FALSE
40	-1.09	0.81	FALSE	FALSE	90	-0.86	0.86	FALSE	FALSE
41	-1.09	0.81	FALSE	FALSE	91	-0.86	0.86	FALSE	FALSE
42	-1.09	0.81	FALSE	FALSE	92	-0.86	0.86	FALSE	FALSE
43	-1.09	0.81	FALSE	FALSE	93	-0.86	0.86	FALSE	FALSE
44	-1.11	0.83	FALSE	FALSE	94	-0.86	0.86	FALSE	FALSE
45	-1.11	0.83	FALSE	FALSE	95	-0.86	0.86	FALSE	FALSE
46	-1.11	0.83	FALSE	FALSE	96	-0.86	0.86	FALSE	FALSE
47	-1.11	0.83	FALSE	FALSE	97	-0.86	0.86	FALSE	FALSE
48	-1.03	0.87	FALSE	FALSE	98	-0.86	0.86	FALSE	FALSE
49	-1.03	0.87	FALSE	FALSE	99	-0.86	0.86	FALSE	FALSE
50	-1.03	0.87	FALSE	FALSE	100	-0.86	0.86	FALSE	FALSE

Table 38. Hsu's procedure results for two decision variables for crossover rate = 0.9

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.89	0.99	FALSE	FALSE
2	-2.89	2.97	FALSE	FALSE	52	-0.89	0.99	FALSE	FALSE
3	-3.44	2.22	FALSE	FALSE	53	-0.89	0.99	FALSE	FALSE
4	-2.68	2.56	FALSE	FALSE	54	-0.88	0.98	FALSE	FALSE
5	-3.37	1.71	FALSE	FALSE	55	-0.88	0.98	FALSE	FALSE
6	-3.21	2.01	FALSE	FALSE	56	-0.88	0.98	FALSE	FALSE
7	-2.64	2.10	FALSE	FALSE	57	-0.88	0.98	FALSE	FALSE
8	-2.79	1.09	FALSE	FALSE	58	-0.88	0.98	FALSE	FALSE
9	-2.30	1.34	FALSE	FALSE	59	-0.88	0.98	FALSE	FALSE
10	-2.26	1.34	FALSE	FALSE	60	-0.88	0.98	FALSE	FALSE
11	-2.26	1.34	FALSE	FALSE	61	-1.03	0.75	FALSE	FALSE
12	-2.21	1.33	FALSE	FALSE	62	-1.03	0.75	FALSE	FALSE
13	-2.00	1.20	FALSE	FALSE	63	-1.01	0.79	FALSE	FALSE
14	-1.53	1.03	FALSE	FALSE	64	-1.01	0.79	FALSE	FALSE
15	-1.48	0.98	FALSE	FALSE	65	-1.03	0.75	FALSE	FALSE
16	-1.48	0.98	FALSE	FALSE	66	-1.03	0.75	FALSE	FALSE
17	-1.48	0.98	FALSE	FALSE	67	-0.92	0.84	FALSE	FALSE
18	-1.48	0.98	FALSE	FALSE	68	-0.92	0.84	FALSE	FALSE
19	-1.48	0.98	FALSE	FALSE	69	-0.92	0.84	FALSE	FALSE
20	-1.48	0.98	FALSE	FALSE	70	-0.92	0.84	FALSE	FALSE
21	-1.48	0.98	FALSE	FALSE	71	-0.92	0.84	FALSE	FALSE
22	-1.49	0.97	FALSE	FALSE	72	-0.92	0.84	FALSE	FALSE
23	-1.42	1.08	FALSE	FALSE	73	-0.92	0.84	FALSE	FALSE
24	-1.42	1.08	FALSE	FALSE	74	-0.92	0.84	FALSE	FALSE
25	-1.42	1.08	FALSE	FALSE	75	-0.92	0.84	FALSE	FALSE
26	-1.42	1.08	FALSE	FALSE	76	-0.92	0.84	FALSE	FALSE
27	-1.42	1.08	FALSE	FALSE	77	-0.92	0.84	FALSE	FALSE
28	-1.42	1.08	FALSE	FALSE	78	-0.92	0.84	FALSE	FALSE
29	-1.42	1.08	FALSE	FALSE	79	-0.92	0.84	FALSE	FALSE
30	-1.42	1.08	FALSE	FALSE	80	-0.92	0.84	FALSE	FALSE
31	-1.42	1.08	FALSE	FALSE	81	-0.92	0.84	FALSE	FALSE
32	-1.42	1.08	FALSE	FALSE	82	-0.92	0.84	FALSE	FALSE
33	-1.42	1.08	FALSE	FALSE	83	-0.86	0.86	FALSE	FALSE
34	-1.42	1.08	FALSE	FALSE	84	-0.86	0.86	FALSE	FALSE
35	-1.36	1.12	FALSE	FALSE	85	-0.86	0.86	FALSE	FALSE
36	-1.12	1.20	FALSE	FALSE	86	-0.86	0.86	FALSE	FALSE
37	-0.68	1.20	FALSE	FALSE	87	-0.86	0.86	FALSE	FALSE
38	-0.68	1.20	FALSE	FALSE	88	-0.86	0.86	FALSE	FALSE
39	-0.55	1.35	FALSE	FALSE	89	-0.86	0.86	FALSE	FALSE
40	-0.55	1.35	FALSE	FALSE	90	-0.86	0.86	FALSE	FALSE
41	-0.55	1.35	FALSE	FALSE	91	-0.86	0.86	FALSE	FALSE
42	-0.62	1.28	FALSE	FALSE	92	-0.86	0.86	FALSE	FALSE
43	-0.62	1.28	FALSE	FALSE	93	-0.86	0.86	FALSE	FALSE
44	-0.74	1.20	FALSE	FALSE	94	-0.86	0.86	FALSE	FALSE
45	-0.74	1.20	FALSE	FALSE	95	-0.86	0.86	FALSE	FALSE
46	-0.75	1.19	FALSE	FALSE	96	-0.86	0.86	FALSE	FALSE
47	-0.75	1.19	FALSE	FALSE	97	-0.86	0.86	FALSE	FALSE
48	-0.87	1.03	FALSE	FALSE	98	-0.86	0.86	FALSE	FALSE
49	-0.87	1.03	FALSE	FALSE	99	-0.86	0.86	FALSE	FALSE
50	-0.87	1.03	FALSE	FALSE	100	-0.86	0.86	FALSE	FALSE

Table 39. Hsu's procedure results for six decision variables for crossover rate = 0.3

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	6.54	32.62	TRUE	FALSE
2	-12.54	40.52	FALSE	FALSE	52	7.28	30.88	TRUE	FALSE
3	-5.61	40.11	FALSE	FALSE	53	7.27	31.05	TRUE	FALSE
4	-3.58	38.78	FALSE	FALSE	54	8.18	30.78	TRUE	FALSE
5	-7.05	33.21	FALSE	FALSE	55	6.83	29.71	TRUE	FALSE
6	-1.06	40.94	FALSE	FALSE	56	6.75	29.85	TRUE	FALSE
7	1.40	39.70	TRUE	FALSE	57	4.58	27.82	TRUE	FALSE
8	7.15	44.47	TRUE	FALSE	58	2.27	26.25	TRUE	FALSE
9	1.46	41.32	TRUE	FALSE	59	1.98	26.22	TRUE	FALSE
10	10.04	42.52	TRUE	FALSE	60	2.05	26.29	TRUE	FALSE
11	4.50	36.66	TRUE	FALSE	61	4.10	23.60	TRUE	FALSE
12	5.95	37.95	TRUE	FALSE	62	4.71	23.59	TRUE	FALSE
13	4.18	37.82	TRUE	FALSE	63	4.77	23.55	TRUE	FALSE
14	4.34	38.06	TRUE	FALSE	64	4.98	23.34	TRUE	FALSE
15	5.01	39.57	TRUE	FALSE	65	4.76	23.20	TRUE	FALSE
16	7.05	40.95	TRUE	FALSE	66	4.78	23.18	TRUE	FALSE
17	8.52	42.82	TRUE	FALSE	67	5.79	23.91	TRUE	FALSE
18	8.78	43.20	TRUE	FALSE	68	6.24	24.36	TRUE	FALSE
19	8.90	43.86	TRUE	FALSE	69	5.72	22.94	TRUE	FALSE
20	8.52	43.86	TRUE	FALSE	70	5.95	23.31	TRUE	FALSE
21	11.21	45.85	TRUE	FALSE	71	6.30	23.42	TRUE	FALSE
22	8.13	41.55	TRUE	FALSE	72	5.93	22.55	TRUE	FALSE
23	6.64	39.76	TRUE	FALSE	73	4.86	21.96	TRUE	FALSE
24	4.08	37.58	TRUE	FALSE	74	4.95	21.77	TRUE	FALSE
25	6.28	38.86	TRUE	FALSE	75	5.31	21.99	TRUE	FALSE
26	6.28	38.86	TRUE	FALSE	76	4.97	20.39	TRUE	FALSE
27	6.80	40.16	TRUE	FALSE	77	4.60	20.02	TRUE	FALSE
28	6.18	39.04	TRUE	FALSE	78	5.46	21.32	TRUE	FALSE
29	6.36	39.60	TRUE	FALSE	79	5.52	20.72	TRUE	FALSE
30	4.93	38.19	TRUE	FALSE	80	5.52	20.72	TRUE	FALSE
31	6.86	39.22	TRUE	FALSE	81	5.56	20.68	TRUE	FALSE
32	4.35	38.91	TRUE	FALSE	82	5.83	20.65	TRUE	FALSE
33	3.23	37.49	TRUE	FALSE	83	5.83	20.65	TRUE	FALSE
34	3.49	37.71	TRUE	FALSE	84	5.23	20.07	TRUE	FALSE
35	3.49	37.71	TRUE	FALSE	85	5.67	20.49	TRUE	FALSE
36	2.55	34.25	TRUE	FALSE	86	5.19	19.31	TRUE	FALSE
37	3.35	33.89	TRUE	FALSE	87	5.22	19.28	TRUE	FALSE
38	6.86	35.08	TRUE	FALSE	88	5.66	19.72	TRUE	FALSE
39	6.00	34.66	TRUE	FALSE	89	5.65	19.73	TRUE	FALSE
40	6.35	35.93	TRUE	FALSE	90	3.89	19.09	TRUE	FALSE
41	5.86	35.84	TRUE	FALSE	91	3.14	17.96	TRUE	FALSE
42	9.67	37.13	TRUE	FALSE	92	3.33	17.77	TRUE	FALSE
43	10.55	37.83	TRUE	FALSE	93	3.36	17.60	TRUE	FALSE
44	10.57	37.89	TRUE	FALSE	94	2.67	16.49	TRUE	FALSE
45	9.68	37.42	TRUE	FALSE	95	2.76	16.64	TRUE	FALSE
46	9.58	37.52	TRUE	FALSE	96	2.82	16.58	TRUE	FALSE
47	7.94	34.66	TRUE	FALSE	97	2.89	16.51	TRUE	FALSE
48	8.20	34.06	TRUE	FALSE	98	2.74	16.32	TRUE	FALSE
49	8.77	34.35	TRUE	FALSE	99	2.67	16.39	TRUE	FALSE
50	8.47	33.91	TRUE	FALSE	100	2.89	15.71	TRUE	FALSE

Table 39. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	3.17	16.37	TRUE	FALSE	151	0.95	13.89	TRUE	FALSE
102	3.15	16.39	TRUE	FALSE	152	0.83	13.87	TRUE	FALSE
103	3.05	16.49	TRUE	FALSE	153	0.37	12.93	TRUE	FALSE
104	2.98	16.56	TRUE	FALSE	154	0.17	12.73	TRUE	FALSE
105	2.98	16.56	TRUE	FALSE	155	0.26	12.80	TRUE	FALSE
106	3.71	16.25	TRUE	FALSE	156	0.26	12.80	TRUE	FALSE
107	2.69	15.49	TRUE	FALSE	157	0.29	12.77	TRUE	FALSE
108	2.23	15.41	TRUE	FALSE	158	0.33	12.73	TRUE	FALSE
109	2.43	15.55	TRUE	FALSE	159	0.21	12.83	TRUE	FALSE
110	1.88	14.48	TRUE	FALSE	160	0.01	13.03	TRUE	FALSE
111	1.88	14.48	TRUE	FALSE	161	0.01	13.03	TRUE	FALSE
112	1.89	14.47	TRUE	FALSE	162	0.08	13.18	TRUE	FALSE
113	1.89	14.47	TRUE	FALSE	163	0.08	13.18	TRUE	FALSE
114	0.56	12.92	TRUE	FALSE	164	0.27	13.37	TRUE	FALSE
115	0.54	12.94	TRUE	FALSE	165	-0.03	13.01	FALSE	FALSE
116	0.28	12.86	TRUE	FALSE	166	-0.03	13.01	FALSE	FALSE
117	0.28	12.86	TRUE	FALSE	167	-0.04	13.02	FALSE	FALSE
118	0.57	12.53	TRUE	FALSE	168	-0.04	13.02	FALSE	FALSE
119	-0.16	12.20	FALSE	FALSE	169	-0.04	13.02	FALSE	FALSE
120	-0.27	11.99	FALSE	FALSE	170	0.30	13.50	TRUE	FALSE
121	-0.27	11.99	FALSE	FALSE	171	0.30	13.50	TRUE	FALSE
122	-0.02	12.24	FALSE	FALSE	172	0.30	13.50	TRUE	FALSE
123	-0.04	12.20	FALSE	FALSE	173	0.29	13.49	TRUE	FALSE
124	0.50	12.74	TRUE	FALSE	174	0.29	13.49	TRUE	FALSE
125	0.73	12.51	TRUE	FALSE	175	0.29	13.49	TRUE	FALSE
126	0.73	12.51	TRUE	FALSE	176	0.13	13.41	TRUE	FALSE
127	0.73	12.51	TRUE	FALSE	177	0.13	13.41	TRUE	FALSE
128	0.98	12.76	TRUE	FALSE	178	0.13	13.41	TRUE	FALSE
129	0.94	12.80	TRUE	FALSE	179	-0.11	13.11	FALSE	FALSE
130	0.93	12.63	TRUE	FALSE	180	-0.11	13.11	FALSE	FALSE
131	1.10	13.02	TRUE	FALSE	181	0.25	13.13	TRUE	FALSE
132	1.02	12.86	TRUE	FALSE	182	0.25	13.13	TRUE	FALSE
133	1.02	12.86	TRUE	FALSE	183	-1.17	12.31	FALSE	FALSE
134	1.02	12.86	TRUE	FALSE	184	-1.20	12.34	FALSE	FALSE
135	1.01	12.87	TRUE	FALSE	185	-1.20	12.34	FALSE	FALSE
136	0.75	12.75	TRUE	FALSE	186	-0.52	11.58	FALSE	FALSE
137	0.75	12.75	TRUE	FALSE	187	-0.48	11.54	FALSE	FALSE
138	0.42	12.48	TRUE	FALSE	188	-0.49	11.55	FALSE	FALSE
139	0.91	12.77	TRUE	FALSE	189	-0.54	11.40	FALSE	FALSE
140	0.91	12.77	TRUE	FALSE	190	-0.54	11.40	FALSE	FALSE
141	1.26	13.32	TRUE	FALSE	191	-0.54	11.40	FALSE	FALSE
142	1.52	13.92	TRUE	FALSE	192	-0.54	11.40	FALSE	FALSE
143	1.09	13.53	TRUE	FALSE	193	-0.84	10.78	FALSE	FALSE
144	1.19	13.43	TRUE	FALSE	194	-0.36	11.02	FALSE	FALSE
145	1.18	13.44	TRUE	FALSE	195	-0.41	11.01	FALSE	FALSE
146	1.24	13.50	TRUE	FALSE	196	-0.41	11.01	FALSE	FALSE
147	1.17	13.57	TRUE	FALSE	197	0.96	11.52	TRUE	FALSE
148	0.98	13.20	TRUE	FALSE	198	0.61	11.11	TRUE	FALSE
149	0.95	13.23	TRUE	FALSE	199	0.92	11.42	TRUE	FALSE
150	0.71	13.47	TRUE	FALSE	200	0.92	11.42	TRUE	FALSE

Table 40. Hsu's procedure results for six decision variables for crossover rate = 0.5

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	0.77	26.85	TRUE	FALSE
2	-24.81	28.25	FALSE	FALSE	52	2.00	25.60	TRUE	FALSE
3	-23.00	22.72	FALSE	FALSE	53	2.28	26.06	TRUE	FALSE
4	-24.95	17.41	FALSE	FALSE	54	2.33	24.93	TRUE	FALSE
5	-12.78	27.48	FALSE	FALSE	55	1.29	24.17	TRUE	FALSE
6	-14.14	27.86	FALSE	FALSE	56	0.69	23.79	TRUE	FALSE
7	-9.76	28.54	FALSE	FALSE	57	0.52	23.76	TRUE	FALSE
8	-5.29	32.03	FALSE	FALSE	58	-0.19	23.79	FALSE	FALSE
9	-7.91	31.95	FALSE	FALSE	59	-0.24	24.00	FALSE	FALSE
10	-4.47	28.01	FALSE	FALSE	60	0.63	24.87	TRUE	FALSE
11	-6.15	26.01	FALSE	FALSE	61	-0.68	18.82	FALSE	FALSE
12	-3.33	28.67	FALSE	FALSE	62	0.72	19.60	TRUE	FALSE
13	-5.37	28.27	FALSE	FALSE	63	0.63	19.41	TRUE	FALSE
14	-5.81	27.91	FALSE	FALSE	64	0.41	18.77	TRUE	FALSE
15	-5.73	28.83	FALSE	FALSE	65	-0.03	18.41	FALSE	FALSE
16	-4.68	29.22	FALSE	FALSE	66	-0.90	17.50	FALSE	FALSE
17	-3.96	30.34	FALSE	FALSE	67	-0.53	17.59	FALSE	FALSE
18	-2.13	32.29	FALSE	FALSE	68	-0.47	17.65	FALSE	FALSE
19	-3.02	31.94	FALSE	FALSE	69	0.70	17.92	TRUE	FALSE
20	-3.21	32.13	FALSE	FALSE	70	0.57	17.93	TRUE	FALSE
21	-0.76	33.88	FALSE	FALSE	71	0.92	18.04	TRUE	FALSE
22	1.04	34.46	TRUE	FALSE	72	1.17	17.79	TRUE	FALSE
23	1.43	34.55	TRUE	FALSE	73	0.93	18.03	TRUE	FALSE
24	-2.36	31.14	FALSE	FALSE	74	0.74	17.56	TRUE	FALSE
25	-2.12	30.46	FALSE	FALSE	75	-1.01	15.67	FALSE	FALSE
26	-2.12	30.46	FALSE	FALSE	76	-1.72	13.70	FALSE	FALSE
27	-3.39	29.97	FALSE	FALSE	77	-2.85	12.57	FALSE	FALSE
28	-4.58	28.28	FALSE	FALSE	78	-2.44	13.42	FALSE	FALSE
29	-5.34	27.90	FALSE	FALSE	79	-2.88	12.32	FALSE	FALSE
30	-6.25	27.01	FALSE	FALSE	80	-2.88	12.32	FALSE	FALSE
31	-4.85	27.51	FALSE	FALSE	81	-2.84	12.28	FALSE	FALSE
32	-8.46	26.10	FALSE	FALSE	82	-2.57	12.25	FALSE	FALSE
33	-7.41	26.85	FALSE	FALSE	83	-2.57	12.25	FALSE	FALSE
34	-7.15	27.07	FALSE	FALSE	84	-2.58	12.26	FALSE	FALSE
35	-7.15	27.07	FALSE	FALSE	85	-2.25	12.57	FALSE	FALSE
36	-4.86	26.84	FALSE	FALSE	86	-2.27	11.85	FALSE	FALSE
37	-2.60	27.94	FALSE	FALSE	87	-2.34	11.72	FALSE	FALSE
38	-1.55	26.67	FALSE	FALSE	88	-1.65	12.41	FALSE	FALSE
39	-2.68	25.98	FALSE	FALSE	89	-1.83	12.25	FALSE	FALSE
40	-2.33	27.25	FALSE	FALSE	90	-1.69	13.51	FALSE	FALSE
41	-2.62	27.36	FALSE	FALSE	91	-1.89	12.93	FALSE	FALSE
42	-0.01	27.45	FALSE	FALSE	92	-1.70	12.74	FALSE	FALSE
43	0.87	28.15	TRUE	FALSE	93	-1.53	12.71	FALSE	FALSE
44	0.31	27.63	TRUE	FALSE	94	-1.51	12.31	FALSE	FALSE
45	-0.26	27.48	FALSE	FALSE	95	-1.37	12.51	FALSE	FALSE
46	-0.36	27.58	FALSE	FALSE	96	-1.44	12.32	FALSE	FALSE
47	0.65	27.37	TRUE	FALSE	97	-1.37	12.25	FALSE	FALSE
48	1.96	27.82	TRUE	FALSE	98	-2.32	11.26	FALSE	FALSE
49	2.39	27.97	TRUE	FALSE	99	-2.51	11.21	FALSE	FALSE
50	1.98	27.42	TRUE	FALSE	100	-3.28	9.54	FALSE	FALSE

Table 40. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	-2.86	10.34	FALSE	FALSE	151	-4.08	8.86	FALSE	FALSE
102	-2.88	10.36	FALSE	FALSE	152	-4.02	9.02	FALSE	FALSE
103	-3.74	9.70	FALSE	FALSE	153	-4.48	8.08	FALSE	FALSE
104	-3.81	9.77	FALSE	FALSE	154	-4.90	7.66	FALSE	FALSE
105	-3.81	9.77	FALSE	FALSE	155	-4.81	7.73	FALSE	FALSE
106	-2.32	10.22	FALSE	FALSE	156	-4.81	7.73	FALSE	FALSE
107	-2.45	10.35	FALSE	FALSE	157	-4.78	7.70	FALSE	FALSE
108	-2.53	10.65	FALSE	FALSE	158	-4.74	7.66	FALSE	FALSE
109	-2.76	10.36	FALSE	FALSE	159	-5.11	7.51	FALSE	FALSE
110	-2.41	10.19	FALSE	FALSE	160	-5.96	7.06	FALSE	FALSE
111	-2.41	10.19	FALSE	FALSE	161	-5.96	7.06	FALSE	FALSE
112	-3.87	8.71	FALSE	FALSE	162	-5.89	7.21	FALSE	FALSE
113	-3.87	8.71	FALSE	FALSE	163	-5.89	7.21	FALSE	FALSE
114	-3.76	8.60	FALSE	FALSE	164	-5.70	7.40	FALSE	FALSE
115	-4.49	7.91	FALSE	FALSE	165	-5.67	7.37	FALSE	FALSE
116	-4.55	8.03	FALSE	FALSE	166	-5.67	7.37	FALSE	FALSE
117	-4.55	8.03	FALSE	FALSE	167	-5.74	7.32	FALSE	FALSE
118	-4.13	7.83	FALSE	FALSE	168	-5.74	7.32	FALSE	FALSE
119	-4.33	8.03	FALSE	FALSE	169	-5.74	7.32	FALSE	FALSE
120	-4.51	7.75	FALSE	FALSE	170	-5.40	7.80	FALSE	FALSE
121	-4.51	7.75	FALSE	FALSE	171	-5.40	7.80	FALSE	FALSE
122	-4.63	7.63	FALSE	FALSE	172	-5.40	7.80	FALSE	FALSE
123	-4.28	7.96	FALSE	FALSE	173	-5.40	7.80	FALSE	FALSE
124	-4.22	8.02	FALSE	FALSE	174	-5.40	7.80	FALSE	FALSE
125	-3.99	7.79	FALSE	FALSE	175	-5.40	7.80	FALSE	FALSE
126	-3.99	7.79	FALSE	FALSE	176	-5.44	7.84	FALSE	FALSE
127	-3.99	7.79	FALSE	FALSE	177	-5.44	7.84	FALSE	FALSE
128	-3.74	8.04	FALSE	FALSE	178	-5.44	7.84	FALSE	FALSE
129	-4.08	7.78	FALSE	FALSE	179	-5.41	7.81	FALSE	FALSE
130	-4.62	7.08	FALSE	FALSE	180	-5.41	7.81	FALSE	FALSE
131	-4.97	6.95	FALSE	FALSE	181	-5.11	7.77	FALSE	FALSE
132	-4.93	6.91	FALSE	FALSE	182	-5.11	7.77	FALSE	FALSE
133	-4.93	6.91	FALSE	FALSE	183	-5.41	8.07	FALSE	FALSE
134	-4.93	6.91	FALSE	FALSE	184	-5.62	7.92	FALSE	FALSE
135	-5.05	6.81	FALSE	FALSE	185	-5.62	7.92	FALSE	FALSE
136	-4.95	7.05	FALSE	FALSE	186	-4.77	7.33	FALSE	FALSE
137	-4.95	7.05	FALSE	FALSE	187	-4.83	7.19	FALSE	FALSE
138	-4.88	7.18	FALSE	FALSE	188	-4.84	7.20	FALSE	FALSE
139	-4.39	7.47	FALSE	FALSE	189	-4.79	7.15	FALSE	FALSE
140	-4.39	7.47	FALSE	FALSE	190	-4.79	7.15	FALSE	FALSE
141	-4.04	8.02	FALSE	FALSE	191	-4.79	7.15	FALSE	FALSE
142	-2.83	9.57	FALSE	FALSE	192	-4.79	7.15	FALSE	FALSE
143	-2.85	9.59	FALSE	FALSE	193	-4.63	6.99	FALSE	FALSE
144	-2.75	9.49	FALSE	FALSE	194	-4.15	7.23	FALSE	FALSE
145	-2.81	9.45	FALSE	FALSE	195	-4.17	7.25	FALSE	FALSE
146	-2.75	9.51	FALSE	FALSE	196	-4.17	7.25	FALSE	FALSE
147	-3.16	9.24	FALSE	FALSE	197	-3.48	7.08	FALSE	FALSE
148	-3.07	9.15	FALSE	FALSE	198	-4.19	6.31	FALSE	FALSE
149	-3.34	8.94	FALSE	FALSE	199	-3.75	6.75	FALSE	FALSE
150	-4.32	8.44	FALSE	FALSE	200	-3.75	6.75	FALSE	FALSE

Table 41. Hsu's procedure results for six decision variables for crossover rate = 0.7

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	-17.11	8.97	FALSE	FALSE
2	-20.53	32.53	FALSE	FALSE	52	-14.65	8.95	FALSE	FALSE
3	-22.72	23.00	FALSE	FALSE	53	-15.50	8.28	FALSE	FALSE
4	-17.06	25.30	FALSE	FALSE	54	-15.06	7.54	FALSE	FALSE
5	-9.93	30.33	FALSE	FALSE	55	-15.66	7.22	FALSE	FALSE
6	-26.34	15.66	FALSE	FALSE	56	-15.80	7.30	FALSE	FALSE
7	-19.47	18.83	FALSE	FALSE	57	-14.97	8.27	FALSE	FALSE
8	-20.00	17.32	FALSE	FALSE	58	-15.46	8.52	FALSE	FALSE
9	-21.77	18.09	FALSE	FALSE	59	-14.99	9.25	FALSE	FALSE
10	-21.61	10.87	FALSE	FALSE	60	-15.86	8.38	FALSE	FALSE
11	-16.91	15.25	FALSE	FALSE	61	-12.57	6.93	FALSE	FALSE
12	-19.62	12.38	FALSE	FALSE	62	-12.40	6.48	FALSE	FALSE
13	-21.19	12.45	FALSE	FALSE	63	-12.36	6.42	FALSE	FALSE
14	-16.59	17.13	FALSE	FALSE	64	-11.15	7.21	FALSE	FALSE
15	-15.92	18.64	FALSE	FALSE	65	-10.81	7.63	FALSE	FALSE
16	-14.67	19.23	FALSE	FALSE	66	-10.50	7.90	FALSE	FALSE
17	-14.67	19.63	FALSE	FALSE	67	-11.21	6.91	FALSE	FALSE
18	-14.42	20.00	FALSE	FALSE	68	-11.95	6.17	FALSE	FALSE
19	-16.27	18.69	FALSE	FALSE	69	-12.22	5.00	FALSE	FALSE
20	-16.78	18.56	FALSE	FALSE	70	-12.59	4.77	FALSE	FALSE
21	-18.97	15.67	FALSE	FALSE	71	-12.18	4.94	FALSE	FALSE
22	-18.74	14.68	FALSE	FALSE	72	-11.93	4.69	FALSE	FALSE
23	-19.64	13.48	FALSE	FALSE	73	-11.45	5.65	FALSE	FALSE
24	-19.22	14.28	FALSE	FALSE	74	-11.31	5.51	FALSE	FALSE
25	-20.01	12.57	FALSE	FALSE	75	-11.19	5.49	FALSE	FALSE
26	-20.01	12.57	FALSE	FALSE	76	-10.25	5.17	FALSE	FALSE
27	-20.65	12.71	FALSE	FALSE	77	-10.29	5.13	FALSE	FALSE
28	-20.19	12.67	FALSE	FALSE	78	-11.18	4.68	FALSE	FALSE
29	-20.53	12.71	FALSE	FALSE	79	-10.85	4.35	FALSE	FALSE
30	-20.65	12.61	FALSE	FALSE	80	-10.85	4.35	FALSE	FALSE
31	-22.27	10.09	FALSE	FALSE	81	-10.49	4.63	FALSE	FALSE
32	-22.14	12.42	FALSE	FALSE	82	-10.04	4.78	FALSE	FALSE
33	-22.60	11.66	FALSE	FALSE	83	-10.04	4.78	FALSE	FALSE
34	-22.52	11.70	FALSE	FALSE	84	-10.05	4.79	FALSE	FALSE
35	-22.50	11.72	FALSE	FALSE	85	-10.81	4.01	FALSE	FALSE
36	-19.90	11.80	FALSE	FALSE	86	-9.91	4.21	FALSE	FALSE
37	-20.05	10.49	FALSE	FALSE	87	-9.33	4.73	FALSE	FALSE
38	-21.03	7.19	FALSE	FALSE	88	-10.02	4.04	FALSE	FALSE
39	-21.73	6.93	FALSE	FALSE	89	-10.03	4.05	FALSE	FALSE
40	-21.49	8.09	FALSE	FALSE	90	-11.34	3.86	FALSE	FALSE
41	-21.16	8.82	FALSE	FALSE	91	-11.15	3.67	FALSE	FALSE
42	-23.08	4.38	FALSE	FALSE	92	-10.52	3.92	FALSE	FALSE
43	-22.14	5.14	FALSE	FALSE	93	-10.49	3.75	FALSE	FALSE
44	-21.89	5.43	FALSE	FALSE	94	-9.58	4.24	FALSE	FALSE
45	-19.90	7.84	FALSE	FALSE	95	-9.70	4.18	FALSE	FALSE
46	-18.81	9.13	FALSE	FALSE	96	-9.64	4.12	FALSE	FALSE
47	-17.21	9.51	FALSE	FALSE	97	-9.05	4.57	FALSE	FALSE
48	-16.34	9.52	FALSE	FALSE	98	-9.03	4.55	FALSE	FALSE
49	-17.13	8.45	FALSE	FALSE	99	-8.69	5.03	FALSE	FALSE
50	-16.79	8.65	FALSE	FALSE	100	-7.65	5.17	FALSE	FALSE

Table 41. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	-8.45	4.75	FALSE	FALSE	151	-3.54	9.40	FALSE	FALSE
102	-8.39	4.85	FALSE	FALSE	152	-3.67	9.37	FALSE	FALSE
103	-8.43	5.01	FALSE	FALSE	153	-3.58	8.98	FALSE	FALSE
104	-7.15	6.43	FALSE	FALSE	154	-3.73	8.83	FALSE	FALSE
105	-7.09	6.49	FALSE	FALSE	155	-3.64	8.90	FALSE	FALSE
106	-5.30	7.24	FALSE	FALSE	156	-3.64	8.90	FALSE	FALSE
107	-5.43	7.37	FALSE	FALSE	157	-3.77	8.71	FALSE	FALSE
108	-5.51	7.67	FALSE	FALSE	158	-4.14	8.26	FALSE	FALSE
109	-5.31	7.81	FALSE	FALSE	159	-4.70	7.92	FALSE	FALSE
110	-4.96	7.64	FALSE	FALSE	160	-4.90	8.12	FALSE	FALSE
111	-4.96	7.64	FALSE	FALSE	161	-4.90	8.12	FALSE	FALSE
112	-4.95	7.63	FALSE	FALSE	162	-4.93	8.17	FALSE	FALSE
113	-4.95	7.63	FALSE	FALSE	163	-5.10	8.00	FALSE	FALSE
114	-4.84	7.52	FALSE	FALSE	164	-5.05	8.05	FALSE	FALSE
115	-4.86	7.54	FALSE	FALSE	165	-5.34	7.70	FALSE	FALSE
	-4.94	7.64	FALSE	FALSE	166	-5.34	7.70	FALSE	FALSE
117	-4.94	7.64	FALSE	FALSE	167	-5.35	7.71	FALSE	FALSE
118	-5.20	6.76	FALSE	FALSE	168	-5.35	7.71	FALSE	FALSE
119	-5.40	6.96	FALSE	FALSE	169	-5.35	7.71	FALSE	FALSE
120	-5.35	6.91	FALSE	FALSE	170	-5.24	7.96	FALSE	FALSE
121	-5.35	6.91	FALSE	FALSE	171	-5.24	7.96	FALSE	FALSE
122	-5.10	7.16	FALSE	FALSE	172	-5.24	7.96	FALSE	FALSE
123	-4.75	7.49	FALSE	FALSE	173	-5.24	7.96	FALSE	FALSE
124	-4.21	8.03	FALSE	FALSE	174	-5.24	7.96	FALSE	FALSE
125	-4.81	6.97	FALSE	FALSE	175	-5.24	7.96	FALSE	FALSE
126	-4.81	6.97	FALSE	FALSE	176	-5.28	8.00	FALSE	FALSE
127	-4.81	6.97	FALSE	FALSE	177	-5.28	8.00	FALSE	FALSE
128	-4.56	7.22	FALSE	FALSE	178	-5.28	8.00	FALSE	FALSE
129	-4.60	7.26	FALSE	FALSE	179	-5.25	7.97	FALSE	FALSE
130	-4.86	6.84	FALSE	FALSE	180	-5.25	7.97	FALSE	FALSE
131	-4.69	7.23	FALSE	FALSE	181	-5.16	7.72	FALSE	FALSE
132	-4.65	7.19	FALSE	FALSE	182	-5.16	7.72	FALSE	FALSE
133	-4.65	7.19	FALSE	FALSE	183	-5.49	7.99	FALSE	FALSE
134	-4.65	7.19	FALSE	FALSE	184	-5.81	7.73	FALSE	FALSE
135	-4.66	7.20	FALSE	FALSE	185	-5.81	7.73	FALSE	FALSE
136	-4.97	7.03	FALSE	FALSE	186	-5.17	6.93	FALSE	FALSE
137	-4.97	7.03	FALSE	FALSE	187	-5.13	6.89	FALSE	FALSE
138	-4.67	7.39	FALSE	FALSE	188	-5.44	6.60	FALSE	FALSE
139	-4.18	7.68	FALSE	FALSE	189	-5.39	6.55	FALSE	FALSE
140	-4.35	7.51	FALSE	FALSE	190	-5.39	6.55	FALSE	FALSE
141	-4.11	7.95	FALSE	FALSE	191	-5.39	6.55	FALSE	FALSE
142	-3.31	9.09	FALSE	FALSE	192	-5.39	6.55	FALSE	FALSE
143	-3.47	8.97	FALSE	FALSE	193	-5.23	6.39	FALSE	FALSE
144	-3.56	8.68	FALSE	FALSE	194	-4.75	6.63	FALSE	FALSE
145	-3.57	8.69	FALSE	FALSE	195	-4.77	6.65	FALSE	FALSE
146	-3.51	8.75	FALSE	FALSE	196	-4.77	6.65	FALSE	FALSE
147	-3.58	8.82	FALSE	FALSE	197	-3.40	7.16	FALSE	FALSE
148	-3.49	8.73	FALSE	FALSE	198	-3.57	6.93	FALSE	FALSE
149	-3.52	8.76	FALSE	FALSE	199	-3.13	7.37	FALSE	FALSE
150	-3.76	9.00	FALSE	FALSE	200	-3.13	7.37	FALSE	FALSE

Table 42. Hsu's procedure results for six decision variables for crossover rate = 0.9

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	-8.97	17.11	FALSE	FALSE
2	-28.25	24.81	FALSE	FALSE	52	-8.95	14.65	FALSE	FALSE
3	-16.06	29.66	FALSE	FALSE	53	-8.28	15.50	FALSE	FALSE
4	-17.41	24.95	FALSE	FALSE	54	-7.54	15.06	FALSE	FALSE
5	-27.48	12.78	FALSE	FALSE	55	-7.22	15.66	FALSE	FALSE
6	-15.66	26.34	FALSE	FALSE	56	-7.30	15.80	FALSE	FALSE
7	-18.83	19.47	FALSE	FALSE	57	-8.27	14.97	FALSE	FALSE
8	-17.32	20.00	FALSE	FALSE	58	-8.52	15.46	FALSE	FALSE
9	-18.09	21.77	FALSE	FALSE	59	-9.25	14.99	FALSE	FALSE
10	-10.87	21.61	FALSE	FALSE	60	-8.38	15.86	FALSE	FALSE
11	-15.25	16.91	FALSE	FALSE	61	-6.93	12.57	FALSE	FALSE
12	-12.38	19.62	FALSE	FALSE	62	-6.48	12.40	FALSE	FALSE
13	-12.45	21.19	FALSE	FALSE	63	-6.42	12.36	FALSE	FALSE
14	-17.13	16.59	FALSE	FALSE	64	-7.21	11.15	FALSE	FALSE
15	-18.64	15.92	FALSE	FALSE	65	-7.63	10.81	FALSE	FALSE
16	-19.23	14.67	FALSE	FALSE	66	-7.90	10.50	FALSE	FALSE
17	-19.63	14.67	FALSE	FALSE	67	-6.91	11.21	FALSE	FALSE
18	-20.00	14.42	FALSE	FALSE	68	-6.17	11.95	FALSE	FALSE
19	-18.69	16.27	FALSE	FALSE	69	-5.00	12.22	FALSE	FALSE
20	-18.56	16.78	FALSE	FALSE	70	-4.77	12.59	FALSE	FALSE
21	-15.67	18.97	FALSE	FALSE	71	-4.94	12.18	FALSE	FALSE
22	-14.68	18.74	FALSE	FALSE	72	-4.69	11.93	FALSE	FALSE
23	-13.48	19.64	FALSE	FALSE	73	-5.65	11.45	FALSE	FALSE
24	-14.28	19.22	FALSE	FALSE	74	-5.51	11.31	FALSE	FALSE
25	-12.57	20.01	FALSE	FALSE	75	-5.49	11.19	FALSE	FALSE
26	-12.57	20.01	FALSE	FALSE	76	-5.17	10.25	FALSE	FALSE
27	-12.71	20.65	FALSE	FALSE	77	-5.13	10.29	FALSE	FALSE
28	-12.67	20.19	FALSE	FALSE	78	-4.68	11.18	FALSE	FALSE
29	-12.71	20.53	FALSE	FALSE	79	-4.35	10.85	FALSE	FALSE
30	-12.61	20.65	FALSE	FALSE	80	-4.35	10.85	FALSE	FALSE
31	-10.09	22.27	FALSE	FALSE	81	-4.63	10.49	FALSE	FALSE
32	-12.42	22.14	FALSE	FALSE	82	-4.78	10.04	FALSE	FALSE
33	-11.66	22.60	FALSE	FALSE	83	-4.78	10.04	FALSE	FALSE
34	-11.70	22.52	FALSE	FALSE	84	-4.79	10.05	FALSE	FALSE
35	-11.72	22.50	FALSE	FALSE	85	-4.01	10.81	FALSE	FALSE
36	-11.80	19.90	FALSE	FALSE	86	-4.21	9.91	FALSE	FALSE
37	-10.49	20.05	FALSE	FALSE	87	-4.73	9.33	FALSE	FALSE
38	-7.19	21.03	FALSE	FALSE	88	-4.04	10.02	FALSE	FALSE
39	-6.93	21.73	FALSE	FALSE	89	-4.05	10.03	FALSE	FALSE
40	-8.09	21.49	FALSE	FALSE	90	-3.86	11.34	FALSE	FALSE
41	-8.82	21.16	FALSE	FALSE	91	-3.67	11.15	FALSE	FALSE
42	-4.38	23.08	FALSE	FALSE	92	-3.92	10.52	FALSE	FALSE
43	-5.14	22.14	FALSE	FALSE	93	-3.75	10.49	FALSE	FALSE
44	-5.43	21.89	FALSE	FALSE	94	-4.24	9.58	FALSE	FALSE
45	-7.84	19.90	FALSE	FALSE	95	-4.18	9.70	FALSE	FALSE
46	-9.13	18.81	FALSE	FALSE	96	-4.12	9.64	FALSE	FALSE
47	-9.51	17.21	FALSE	FALSE	97	-4.57	9.05	FALSE	FALSE
48	-9.52	16.34	FALSE	FALSE	98	-4.55	9.03	FALSE	FALSE
49	-8.45	17.13	FALSE	FALSE	99	-5.03	8.69	FALSE	FALSE
50	-8.65	16.79	FALSE	FALSE	100	-5.17	7.65	FALSE	FALSE

Table 42. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	-4.75	8.45	FALSE	FALSE	151	-8.86	4.08	FALSE	FALSE
102	-4.85	8.39	FALSE	FALSE	152	-9.02	4.02	FALSE	FALSE
103	-5.01	8.43	FALSE	FALSE	153	-8.08	4.48	FALSE	FALSE
104	-6.43	7.15	FALSE	FALSE	154	-7.66	4.90	FALSE	FALSE
105	-6.49	7.09	FALSE	FALSE	155	-7.73	4.81	FALSE	FALSE
106	-7.24	5.30	FALSE	FALSE	156	-7.73	4.81	FALSE	FALSE
107	-7.37	5.43	FALSE	FALSE	157	-7.70	4.78	FALSE	FALSE
108	-7.67	5.51	FALSE	FALSE	158	-7.66	4.74	FALSE	FALSE
109	-7.81	5.31	FALSE	FALSE	159	-7.51	5.11	FALSE	FALSE
110	-7.64	4.96	FALSE	FALSE	160	-7.06	5.96	FALSE	FALSE
111	-7.64	4.96	FALSE	FALSE	161	-7.06	5.96	FALSE	FALSE
112	-7.63	4.95	FALSE	FALSE	162	-7.21	5.89	FALSE	FALSE
113	-7.63	4.95	FALSE	FALSE	163	-7.21	5.89	FALSE	FALSE
114	-7.52	4.84	FALSE	FALSE	164	-7.40	5.70	FALSE	FALSE
115	-7.54	4.86	FALSE	FALSE	165	-7.37	5.67	FALSE	FALSE
116	-7.64	4.94	FALSE	FALSE	166	-7.37	5.67	FALSE	FALSE
117	-7.64	4.94	FALSE	FALSE	167	-7.32	5.74	FALSE	FALSE
118	-6.76	5.20	FALSE	FALSE	168	-7.32	5.74	FALSE	FALSE
119	-6.96	5.40	FALSE	FALSE	169	-7.32	5.74	FALSE	FALSE
120	-6.91	5.35	FALSE	FALSE	170	-7.80	5.40	FALSE	FALSE
121	-6.91	5.35	FALSE	FALSE	171	-7.80	5.40	FALSE	FALSE
122	-7.16	5.10	FALSE	FALSE	172	-7.80	5.40	FALSE	FALSE
123	-7.49	4.75	FALSE	FALSE	173	-7.80	5.40	FALSE	FALSE
124	-8.02	4.22	FALSE	FALSE	174	-7.80	5.40	FALSE	FALSE
125	-6.97	4.81	FALSE	FALSE	175	-7.80	5.40	FALSE	FALSE
126	-6.97	4.81	FALSE	FALSE	176	-7.84	5.44	FALSE	FALSE
127	-6.97	4.81	FALSE	FALSE	177	-7.84	5.44	FALSE	FALSE
128	-7.22	4.56	FALSE	FALSE	178	-7.84	5.44	FALSE	FALSE
129	-7.26	4.60	FALSE	FALSE	179	-7.81	5.41	FALSE	FALSE
130	-6.84	4.86	FALSE	FALSE	180	-7.81	5.41	FALSE	FALSE
131	-6.95	4.97	FALSE	FALSE	181	-7.72	5.16	FALSE	FALSE
132	-6.91	4.93	FALSE	FALSE	182	-7.72	5.16	FALSE	FALSE
133	-6.91	4.93	FALSE	FALSE	183	-7.99	5.49	FALSE	FALSE
134	-6.91	4.93	FALSE	FALSE	184	-7.73	5.81	FALSE	FALSE
135	-6.81	5.05	FALSE	FALSE	185	-7.73	5.81	FALSE	FALSE
136	-7.03	4.97	FALSE	FALSE	186	-6.93	5.17	FALSE	FALSE
137	-7.03	4.97	FALSE	FALSE	187	-6.89	5.13	FALSE	FALSE
138	-7.18	4.88	FALSE	FALSE	188	-6.60	5.44	FALSE	FALSE
139	-7.47	4.39	FALSE	FALSE	189	-6.55	5.39	FALSE	FALSE
140	-7.47	4.39	FALSE	FALSE	190	-6.55	5.39	FALSE	FALSE
141	-7.95	4.11	FALSE	FALSE	191	-6.55	5.39	FALSE	FALSE
142	-9.09	3.31	FALSE	FALSE	192	-6.55	5.39	FALSE	FALSE
143	-8.97	3.47	FALSE	FALSE	193	-6.39	5.23	FALSE	FALSE
144	-8.68	3.56	FALSE	FALSE	194	-6.63	4.75	FALSE	FALSE
145	-8.69	3.57	FALSE	FALSE	195	-6.65	4.77	FALSE	FALSE
146	-8.75	3.51	FALSE	FALSE	196	-6.65	4.77	FALSE	FALSE
147	-8.82	3.58	FALSE	FALSE	197	-7.08	3.48	FALSE	FALSE
148	-8.73	3.49	FALSE	FALSE	198	-6.31	4.19	FALSE	FALSE
149	-8.76	3.52	FALSE	FALSE	199	-6.75	3.75	FALSE	FALSE
150	-8.44	4.32	FALSE	FALSE	200	-6.75	3.75	FALSE	FALSE

Table 43. Hsu's procedure results for two decision variables for mutation rate = 0.01

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.01	1.27	FALSE	FALSE
2	-1.67	3.55	FALSE	FALSE	52	-0.01	1.27	FALSE	FALSE
3	-1.44	3.54	FALSE	FALSE	53	0.07	1.31	TRUE	FALSE
4	-1.03	3.41	FALSE	FALSE	54	0.07	1.31	TRUE	FALSE
5	-1.39	2.63	FALSE	FALSE	55	0.07	1.31	TRUE	FALSE
6	-1.23	2.19	FALSE	FALSE	56	0.16	1.36	TRUE	FALSE
7	-0.96	2.40	FALSE	FALSE	57	0.16	1.36	TRUE	FALSE
8	-0.75	2.59	FALSE	FALSE	58	0.16	1.36	TRUE	FALSE
9	-0.72	2.12	FALSE	FALSE	59	0.16	1.36	TRUE	FALSE
10	-0.66	2.18	FALSE	FALSE	60	0.17	1.37	TRUE	FALSE
11	-0.67	2.19	FALSE	FALSE	61	0.17	1.37	TRUE	FALSE
12	-0.65	2.21	FALSE	FALSE	62	0.17	1.37	TRUE	FALSE
13	-0.65	2.21	FALSE	FALSE	63	0.16	1.34	TRUE	FALSE
14	-0.52	2.26	FALSE	FALSE	64	0.16	1.34	TRUE	FALSE
15	-0.54	2.28	FALSE	FALSE	65	0.15	1.29	TRUE	FALSE
16	-0.57	2.31	FALSE	FALSE	66	0.15	1.29	TRUE	FALSE
17	-0.57	2.31	FALSE	FALSE	67	0.16	1.28	TRUE	FALSE
18	-0.55	2.29	FALSE	FALSE	68	0.16	1.28	TRUE	FALSE
19	-0.52	2.32	FALSE	FALSE	69	0.16	1.28	TRUE	FALSE
20	-0.52	2.32	FALSE	FALSE	70	0.16	1.28	TRUE	FALSE
21	-0.52	2.32	FALSE	FALSE	71	0.16	1.28	TRUE	FALSE
22	-0.47	2.27	FALSE	FALSE	72	0.16	1.28	TRUE	FALSE
23	-0.47	2.27	FALSE	FALSE	73	0.16	1.28	TRUE	FALSE
24	-0.46	2.26	FALSE	FALSE	74	0.16	1.28	TRUE	FALSE
25	-0.46	2.26	FALSE	FALSE	75	0.08	1.10	TRUE	FALSE
26	-0.47	2.27	FALSE	FALSE	76	0.08	1.10	TRUE	FALSE
27	-0.45	2.29	FALSE	FALSE	77	0.08	1.10	TRUE	FALSE
28	-0.45	2.29	FALSE	FALSE	78	0.08	1.10	TRUE	FALSE
29	-0.45	2.29	FALSE	FALSE	79	0.08	1.10	TRUE	FALSE
30	-0.45	2.29	FALSE	FALSE	80	0.08	1.10	TRUE	FALSE
31	-0.45	2.29	FALSE	FALSE	81	0.08	1.10	TRUE	FALSE
32	-0.45	2.29	FALSE	FALSE	82	0.08	1.10	TRUE	FALSE
33	-0.45	2.29	FALSE	FALSE	83	0.19	0.99	TRUE	FALSE
34	-0.45	2.29	FALSE	FALSE	84	0.19	0.99	TRUE	FALSE
35	0.18	1.68	TRUE	FALSE	85	0.19	0.99	TRUE	FALSE
36	0.18	1.68	TRUE	FALSE	86	0.19	0.99	TRUE	FALSE
37	0.18	1.68	TRUE	FALSE	87	0.19	0.99	TRUE	FALSE
38	0.18	1.68	TRUE	FALSE	88	0.19	0.99	TRUE	FALSE
39	0.17	1.69	TRUE	FALSE	89	0.18	0.98	TRUE	FALSE
40	0.25	1.61	TRUE	FALSE	90	0.18	0.98	TRUE	FALSE
41	0.25	1.61	TRUE	FALSE	91	0.18	0.98	TRUE	FALSE
42	0.17	1.55	TRUE	FALSE	92	0.18	0.98	TRUE	FALSE
43	0.30	1.58	TRUE	FALSE	93	0.18	0.98	TRUE	FALSE
44	0.18	1.50	TRUE	FALSE	94	0.18	0.98	TRUE	FALSE
45	0.18	1.50	TRUE	FALSE	95	0.18	0.98	TRUE	FALSE
46	0.18	1.50	TRUE	FALSE	96	0.18	0.98	TRUE	FALSE
47	0.18	1.50	TRUE	FALSE	97	0.18	0.98	TRUE	FALSE
48	0.00	1.30	TRUE	FALSE	98	0.18	0.98	TRUE	FALSE
49	0.01	1.31	TRUE	FALSE	99	0.20	1.00	TRUE	FALSE
50	0.01	1.31	TRUE	FALSE	100	0.20	1.00	TRUE	FALSE

Table 44. Hsu's procedure results for two decision variables for mutation rate = 0.05

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.70	0.58	FALSE	FALSE
2	-2.27	2.95	FALSE	FALSE	52	-0.70	0.58	FALSE	FALSE
3	-0.88	4.10	FALSE	FALSE	53	-0.56	0.68	FALSE	FALSE
4	-2.13	2.31	FALSE	FALSE	54	-0.56	0.68	FALSE	FALSE
5	-1.85	2.17	FALSE	FALSE	55	-0.56	0.68	FALSE	FALSE
6	-1.36	2.06	FALSE	FALSE	56	-0.49	0.71	FALSE	FALSE
7	-1.09	2.27	FALSE	FALSE	57	-0.49	0.71	FALSE	FALSE
8	-0.88	2.46	FALSE	FALSE	58	-0.49	0.71	FALSE	FALSE
9	-0.58	2.26	FALSE	FALSE	59	-0.50	0.70	FALSE	FALSE
10	-0.52	2.32	FALSE	FALSE	60	-0.49	0.71	FALSE	FALSE
11	-0.58	2.28	FALSE	FALSE	61	-0.49	0.71	FALSE	FALSE
12	-0.56	2.30	FALSE	FALSE	62	-0.49	0.71	FALSE	FALSE
13	-0.56	2.30	FALSE	FALSE	63	-0.48	0.70	FALSE	FALSE
14	-0.50	2.28	FALSE	FALSE	64	-0.48	0.70	FALSE	FALSE
15	-0.72	2.10	FALSE	FALSE	65	-0.46	0.68	FALSE	FALSE
16	-0.75	2.13	FALSE	FALSE	66	-0.50	0.64	FALSE	FALSE
17	-0.75	2.13	FALSE	FALSE	67	-0.51	0.61	FALSE	FALSE
18	-0.93	1.91	FALSE	FALSE	68	-0.51	0.61	FALSE	FALSE
19	-0.90	1.94	FALSE	FALSE	69	-0.51	0.61	FALSE	FALSE
20	-0.90	1.94	FALSE	FALSE	70	-0.51	0.61	FALSE	FALSE
21	-0.90	1.94	FALSE	FALSE	71	-0.52	0.60	FALSE	FALSE
22	-1.05	1.69	FALSE	FALSE	72	-0.52	0.60	FALSE	FALSE
23	-1.05	1.69	FALSE	FALSE	73	-0.52	0.60	FALSE	FALSE
24	-1.04	1.68	FALSE	FALSE	74	-0.52	0.60	FALSE	FALSE
25	-1.04	1.68	FALSE	FALSE	75	-0.47	0.55	FALSE	FALSE
26	-1.05	1.69	FALSE	FALSE	76	-0.47	0.55	FALSE	FALSE
27	-1.03	1.71	FALSE	FALSE	77	-0.47	0.55	FALSE	FALSE
28	-1.13	1.61	FALSE	FALSE	78	-0.47	0.55	FALSE	FALSE
29	-1.15	1.59	FALSE	FALSE	79	-0.47	0.55	FALSE	FALSE
30	-1.15	1.59	FALSE	FALSE	80	-0.47	0.55	FALSE	FALSE
31	-1.15	1.59	FALSE	FALSE	81	-0.47	0.55	FALSE	FALSE
32	-1.15	1.59	FALSE	FALSE	82	-0.47	0.55	FALSE	FALSE
33	-1.16	1.58	FALSE	FALSE	83	-0.36	0.44	FALSE	FALSE
34	-1.16	1.58	FALSE	FALSE	84	-0.36	0.44	FALSE	FALSE
35	-0.53	0.97	FALSE	FALSE	85	-0.36	0.44	FALSE	FALSE
36	-0.53	0.97	FALSE	FALSE	86	-0.36	0.44	FALSE	FALSE
37	-0.53	0.97	FALSE	FALSE	87	-0.36	0.44	FALSE	FALSE
38	-0.53	0.97	FALSE	FALSE	88	-0.36	0.44	FALSE	FALSE
39	-0.54	0.98	FALSE	FALSE	89	-0.36	0.44	FALSE	FALSE
40	-0.56	0.80	FALSE	FALSE	90	-0.36	0.44	FALSE	FALSE
41	-0.56	0.80	FALSE	FALSE	91	-0.36	0.44	FALSE	FALSE
42	-0.57	0.81	FALSE	FALSE	92	-0.36	0.44	FALSE	FALSE
43	-0.71	0.57	FALSE	FALSE	93	-0.36	0.44	FALSE	FALSE
44	-0.73	0.59	FALSE	FALSE	94	-0.36	0.44	FALSE	FALSE
45	-0.73	0.59	FALSE	FALSE	95	-0.36	0.44	FALSE	FALSE
46	-0.73	0.59	FALSE	FALSE	96	-0.36	0.44	FALSE	FALSE
47	-0.72	0.60	FALSE	FALSE	97	-0.36	0.44	FALSE	FALSE
48	-0.71	0.59	FALSE	FALSE	98	-0.36	0.44	FALSE	FALSE
49	-0.72	0.58	FALSE	FALSE	99	-0.34	0.46	FALSE	FALSE
50	-0.72	0.58	FALSE	FALSE	100	-0.34	0.46	FALSE	FALSE

Table 45. Hsu's procedure results for two decision variables for mutation rate = 0.07

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.44	0.84	FALSE	FALSE
2	-2.31	2.91	FALSE	FALSE	52	-0.44	0.84	FALSE	FALSE
3	-0.92	4.06	FALSE	FALSE	53	-0.36	0.88	FALSE	FALSE
4	-1.28	3.16	FALSE	FALSE	54	-0.36	0.88	FALSE	FALSE
5	-0.97	3.05	FALSE	FALSE	55	-0.36	0.88	FALSE	FALSE
6	-0.48	2.94	FALSE	FALSE	56	-0.27	0.93	FALSE	FALSE
7	-0.55	2.81	FALSE	FALSE	57	-0.27	0.93	FALSE	FALSE
8	-0.34	3.00	FALSE	FALSE	58	-0.27	0.93	FALSE	FALSE
9	0.12	2.96	TRUE	FALSE	59	-0.27	0.93	FALSE	FALSE
10	0.18	3.02	TRUE	FALSE	60	-0.26	0.94	FALSE	FALSE
11	0.17	3.03	TRUE	FALSE	61	-0.26	0.94	FALSE	FALSE
12	0.19	3.05	TRUE	FALSE	62	-0.26	0.94	FALSE	FALSE
13	0.19	3.05	TRUE	FALSE	63	-0.25	0.93	FALSE	FALSE
14	0.23	3.01	TRUE	FALSE	64	-0.25	0.93	FALSE	FALSE
15	0.01	2.83	TRUE	FALSE	65	-0.23	0.91	FALSE	FALSE
16	-0.22	2.66	FALSE	FALSE	66	-0.23	0.91	FALSE	FALSE
17	-0.22	2.66	FALSE	FALSE	67	-0.22	0.90	FALSE	FALSE
18	-0.20	2.64	FALSE	FALSE	68	-0.22	0.90	FALSE	FALSE
19	-0.17	2.67	FALSE	FALSE	69	-0.22	0.90	FALSE	FALSE
20	-0.17	2.67	FALSE	FALSE	70	-0.22	0.90	FALSE	FALSE
21	-0.17	2.67	FALSE	FALSE	71	-0.22	0.90	FALSE	FALSE
22	-0.32	2.42	FALSE	FALSE	72	-0.22	0.90	FALSE	FALSE
23	-0.32	2.42	FALSE	FALSE	73	-0.22	0.90	FALSE	FALSE
24	-0.40	2.32	FALSE	FALSE	74	-0.22	0.90	FALSE	FALSE
25	-0.40	2.32	FALSE	FALSE	75	-0.17	0.85	FALSE	FALSE
26	-0.54	2.20	FALSE	FALSE	76	-0.17	0.85	FALSE	FALSE
27	-0.52	2.22	FALSE	FALSE	77	-0.17	0.85	FALSE	FALSE
28	-0.52	2.22	FALSE	FALSE	78	-0.17	0.85	FALSE	FALSE
29	-0.52	2.22	FALSE	FALSE	79	-0.17	0.85	FALSE	FALSE
30	-0.52	2.22	FALSE	FALSE	80	-0.17	0.85	FALSE	FALSE
31	-0.63	2.11	FALSE	FALSE	81	-0.17	0.85	FALSE	FALSE
32	-0.63	2.11	FALSE	FALSE	82	-0.17	0.85	FALSE	FALSE
33	-0.63	2.11	FALSE	FALSE	83	-0.26	0.54	FALSE	FALSE
34	-0.63	2.11	FALSE	FALSE	84	-0.26	0.54	FALSE	FALSE
35	-0.59	0.91	FALSE	FALSE	85	-0.28	0.52	FALSE	FALSE
36	-0.59	0.91	FALSE	FALSE	86	-0.28	0.52	FALSE	FALSE
37	-0.59	0.91	FALSE	FALSE	87	-0.28	0.52	FALSE	FALSE
38	-0.59	0.91	FALSE	FALSE	88	-0.28	0.52	FALSE	FALSE
39	-0.66	0.86	FALSE	FALSE	89	-0.28	0.52	FALSE	FALSE
40	-0.58	0.78	FALSE	FALSE	90	-0.28	0.52	FALSE	FALSE
41	-0.58	0.78	FALSE	FALSE	91	-0.28	0.52	FALSE	FALSE
42	-0.59	0.79	FALSE	FALSE	92	-0.28	0.52	FALSE	FALSE
43	-0.46	0.82	FALSE	FALSE	93	-0.28	0.52	FALSE	FALSE
44	-0.48	0.84	FALSE	FALSE	94	-0.28	0.52	FALSE	FALSE
45	-0.48	0.84	FALSE	FALSE	95	-0.28	0.52	FALSE	FALSE
46	-0.47	0.85	FALSE	FALSE	96	-0.28	0.52	FALSE	FALSE
47	-0.47	0.85	FALSE	FALSE	97	-0.28	0.52	FALSE	FALSE
48	-0.46	0.84	FALSE	FALSE	98	-0.28	0.52	FALSE	FALSE
49	-0.45	0.85	FALSE	FALSE	99	-0.26	0.54	FALSE	FALSE
50	-0.45	0.85	FALSE	FALSE	100	-0.26	0.54	FALSE	FALSE

Table 46. Hsu's procedure results for two decision variables for mutation rate = 0.10

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-2.90	2.90	FALSE	FALSE	51	-0.58	0.70	FALSE	FALSE
2	-2.91	2.31	FALSE	FALSE	52	-0.58	0.70	FALSE	FALSE
3	-3.54	1.44	FALSE	FALSE	53	-0.68	0.56	FALSE	FALSE
4	-2.31	2.13	FALSE	FALSE	54	-0.68	0.56	FALSE	FALSE
5	-2.17	1.85	FALSE	FALSE	55	-0.68	0.56	FALSE	FALSE
6	-2.06	1.36	FALSE	FALSE	56	-0.71	0.49	FALSE	FALSE
7	-2.27	1.09	FALSE	FALSE	57	-0.71	0.49	FALSE	FALSE
8	-2.46	0.88	FALSE	FALSE	58	-0.71	0.49	FALSE	FALSE
9	-2.12	0.72	FALSE	FALSE	59	-0.70	0.50	FALSE	FALSE
10	-2.18	0.66	FALSE	FALSE	60	-0.71	0.49	FALSE	FALSE
11	-2.19	0.67	FALSE	FALSE	61	-0.71	0.49	FALSE	FALSE
12	-2.21	0.65	FALSE	FALSE	62	-0.71	0.49	FALSE	FALSE
13	-2.21	0.65	FALSE	FALSE	63	-0.70	0.48	FALSE	FALSE
14	-2.26	0.52	FALSE	FALSE	64	-0.70	0.48	FALSE	FALSE
15	-2.10	0.72	FALSE	FALSE	65	-0.68	0.46	FALSE	FALSE
16	-2.13	0.75	FALSE	FALSE	66	-0.64	0.50	FALSE	FALSE
17	-2.13	0.75	FALSE	FALSE	67	-0.61	0.51	FALSE	FALSE
18	-1.91	0.93	FALSE	FALSE	68	-0.61	0.51	FALSE	FALSE
19	-1.94	0.90	FALSE	FALSE	69	-0.61	0.51	FALSE	FALSE
20	-1.94	0.90	FALSE	FALSE	70	-0.61	0.51	FALSE	FALSE
21	-1.94	0.90	FALSE	FALSE	71	-0.60	0.52	FALSE	FALSE
22	-1.69	1.05	FALSE	FALSE	72	-0.60	0.52	FALSE	FALSE
23	-1.69	1.05	FALSE	FALSE	73	-0.60	0.52	FALSE	FALSE
24	-1.68	1.04	FALSE	FALSE	74	-0.60	0.52	FALSE	FALSE
25	-1.68	1.04	FALSE	FALSE	75	-0.55	0.47	FALSE	FALSE
26	-1.69	1.05	FALSE	FALSE	76	-0.55	0.47	FALSE	FALSE
27	-1.71	1.03	FALSE	FALSE	77	-0.55	0.47	FALSE	FALSE
28	-1.61	1.13	FALSE	FALSE	78	-0.55	0.47	FALSE	FALSE
29	-1.59	1.15	FALSE	FALSE	79	-0.55	0.47	FALSE	FALSE
30	-1.59	1.15	FALSE	FALSE	80	-0.55	0.47	FALSE	FALSE
31	-1.59	1.15	FALSE	FALSE	81	-0.55	0.47	FALSE	FALSE
32	-1.59	1.15	FALSE	FALSE	82	-0.55	0.47	FALSE	FALSE
33	-1.58	1.16	FALSE	FALSE	83	-0.44	0.36	FALSE	FALSE
34	-1.58	1.16	FALSE	FALSE	84	-0.44	0.36	FALSE	FALSE
35	-0.91	0.59	FALSE	FALSE	85	-0.44	0.36	FALSE	FALSE
36	-0.91	0.59	FALSE	FALSE	86	-0.44	0.36	FALSE	FALSE
37	-0.91	0.59	FALSE	FALSE	87	-0.44	0.36	FALSE	FALSE
38	-0.91	0.59	FALSE	FALSE	88	-0.44	0.36	FALSE	FALSE
39	-0.86	0.66	FALSE	FALSE	89	-0.44	0.36	FALSE	FALSE
40	-0.78	0.58	FALSE	FALSE	90	-0.44	0.36	FALSE	FALSE
41	-0.78	0.58	FALSE	FALSE	91	-0.44	0.36	FALSE	FALSE
42	-0.79	0.59	FALSE	FALSE	92	-0.44	0.36	FALSE	FALSE
43	-0.57	0.71	FALSE	FALSE	93	-0.44	0.36	FALSE	FALSE
44	-0.59	0.73	FALSE	FALSE	94	-0.44	0.36	FALSE	FALSE
45	-0.59	0.73	FALSE	FALSE	95	-0.44	0.36	FALSE	FALSE
46	-0.59	0.73	FALSE	FALSE	96	-0.44	0.36	FALSE	FALSE
47	-0.60	0.72	FALSE	FALSE	97	-0.44	0.36	FALSE	FALSE
48	-0.59	0.71	FALSE	FALSE	98	-0.44	0.36	FALSE	FALSE
49	-0.58	0.72	FALSE	FALSE	99	-0.46	0.34	FALSE	FALSE
50	-0.58	0.72	FALSE	FALSE	100	-0.46	0.34	FALSE	FALSE

Table 47. Hsu's procedure results for six decision variables for mutation rate = 0.01

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	2.74	23.84	TRUE	FALSE
2	-12.56	33.12	FALSE	FALSE	52	2.61	21.59	TRUE	FALSE
3	-2.78	36.10	FALSE	FALSE	53	2.67	21.53	TRUE	FALSE
4	-7.45	25.81	FALSE	FALSE	54	2.70	21.16	TRUE	FALSE
5	-13.65	22.61	FALSE	FALSE	55	2.51	21.31	TRUE	FALSE
6	-12.46	29.64	FALSE	FALSE	56	2.69	21.19	TRUE	FALSE
7	-18.08	27.00	FALSE	FALSE	57	2.88	20.84	TRUE	FALSE
8	-18.77	25.13	FALSE	FALSE	58	5.84	22.80	TRUE	FALSE
9	-17.53	25.51	FALSE	FALSE	59	4.89	22.39	TRUE	FALSE
10	-13.87	23.81	FALSE	FALSE	60	5.02	22.10	TRUE	FALSE
11	-16.68	21.22	FALSE	FALSE	61	5.18	19.70	TRUE	FALSE
12	-14.09	22.57	FALSE	FALSE	62	4.39	18.59	TRUE	FALSE
13	-10.43	24.99	FALSE	FALSE	63	5.31	19.47	TRUE	FALSE
14	-16.22	18.12	FALSE	FALSE	64	4.35	18.49	TRUE	FALSE
15	-13.89	19.27	FALSE	FALSE	65	3.89	18.19	TRUE	FALSE
16	-12.21	21.55	FALSE	FALSE	66	3.97	18.03	TRUE	FALSE
17	-10.65	22.17	FALSE	FALSE	67	4.33	18.39	TRUE	FALSE
18	-9.98	22.38	FALSE	FALSE	68	4.47	18.39	TRUE	FALSE
19	-9.94	22.54	FALSE	FALSE	69	4.48	18.38	TRUE	FALSE
20	-6.34	27.26	FALSE	FALSE	70	5.10	19.14	TRUE	FALSE
21	-3.71	27.93	FALSE	FALSE	71	4.87	18.63	TRUE	FALSE
22	-0.65	30.33	FALSE	FALSE	72	5.14	18.86	TRUE	FALSE
23	3.12	33.18	TRUE	FALSE	73	4.76	18.50	TRUE	FALSE
24	3.44	32.36	TRUE	FALSE	74	5.18	19.00	TRUE	FALSE
25	6.12	33.14	TRUE	FALSE	75	4.74	18.76	TRUE	FALSE
26	6.62	32.64	TRUE	FALSE	76	6.52	19.72	TRUE	FALSE
27	6.19	32.31	TRUE	FALSE	77	6.53	19.71	TRUE	FALSE
28	6.48	32.52	TRUE	FALSE	78	6.08	19.34	TRUE	FALSE
29	6.20	32.36	TRUE	FALSE	79	6.08	19.34	TRUE	FALSE
30	6.80	32.80	TRUE	FALSE	80	6.12	19.40	TRUE	FALSE
31	7.88	33.28	TRUE	FALSE	81	5.84	19.04	TRUE	FALSE
32	6.54	32.80	TRUE	FALSE	82	6.09	18.71	TRUE	FALSE
33	6.78	32.72	TRUE	FALSE	83	6.10	18.74	TRUE	FALSE
34	7.13	32.31	TRUE	FALSE	84	6.10	18.74	TRUE	FALSE
35	7.65	33.07	TRUE	FALSE	85	6.15	18.37	TRUE	FALSE
36	6.08	31.40	TRUE	FALSE	86	5.80	17.86	TRUE	FALSE
37	8.33	32.23	TRUE	FALSE	87	5.25	17.31	TRUE	FALSE
38	10.40	33.08	TRUE	FALSE	88	6.80	18.58	TRUE	FALSE
39	10.37	33.11	TRUE	FALSE	89	7.02	18.68	TRUE	FALSE
40	9.72	33.94	TRUE	FALSE	90	7.02	18.68	TRUE	FALSE
41	9.62	34.12	TRUE	FALSE	91	7.02	18.68	TRUE	FALSE
42	11.07	32.67	TRUE	FALSE	92	6.82	18.00	TRUE	FALSE
43	9.56	30.90	TRUE	FALSE	93	6.87	17.95	TRUE	FALSE
44	9.06	30.44	TRUE	FALSE	94	6.02	17.40	TRUE	FALSE
45	6.61	28.49	TRUE	FALSE	95	6.71	17.53	TRUE	FALSE
46	5.30	27.42	TRUE	FALSE	96	6.71	17.53	TRUE	FALSE
47	4.03	26.05	TRUE	FALSE	97	6.47	17.13	TRUE	FALSE
48	2.34	24.54	TRUE	FALSE	98	6.47	17.13	TRUE	FALSE
49	2.31	23.91	TRUE	FALSE	99	6.40	17.22	TRUE	FALSE
50	2.73	23.85	TRUE	FALSE	100	6.03	16.41	TRUE	FALSE

Table 47. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	6.03	16.41	TRUE	FALSE	151	1.43	11.57	TRUE	FALSE
102	5.76	16.52	TRUE	FALSE	152	1.33	11.45	TRUE	FALSE
103	5.68	16.48	TRUE	FALSE	153	1.78	11.68	TRUE	FALSE
104	4.28	15.24	TRUE	FALSE	154	1.77	11.69	TRUE	FALSE
105	4.21	15.19	TRUE	FALSE	155	1.69	11.61	TRUE	FALSE
106	3.17	13.69	TRUE	FALSE	156	1.69	11.61	TRUE	FALSE
107	3.22	13.74	TRUE	FALSE	157	1.85	11.67	TRUE	FALSE
108	3.20	13.54	TRUE	FALSE	158	2.03	11.81	TRUE	FALSE
109	3.49	13.71	TRUE	FALSE	159	1.89	11.81	TRUE	FALSE
110	3.68	14.08	TRUE	FALSE	160	1.91	11.85	TRUE	FALSE
111	3.61	14.15	TRUE	FALSE	161	1.91	11.85	TRUE	FALSE
112	3.61	14.15	TRUE	FALSE	162	1.74	11.80	TRUE	FALSE
113	3.61	14.15	TRUE	FALSE	163	1.75	11.79	TRUE	FALSE
114	3.81	14.25	TRUE	FALSE	164	1.52	11.64	TRUE	FALSE
115	3.81	14.25	TRUE	FALSE	165	1.51	11.65	TRUE	FALSE
116	3.68	14.18	TRUE	FALSE	166	1.51	11.65	TRUE	FALSE
117	3.92	14.42	TRUE	FALSE	167	1.93	12.07	TRUE	FALSE
118	4.23	13.89	TRUE	FALSE	168	1.93	12.07	TRUE	FALSE
119	4.21	13.91	TRUE	FALSE	169	2.16	12.40	TRUE	FALSE
120	4.21	13.91	TRUE	FALSE	170	1.66	12.08	TRUE	FALSE
121	4.25	13.93	TRUE	FALSE	171	1.66	12.08	TRUE	FALSE
122	4.02	13.66	TRUE	FALSE	172	1.66	12.08	TRUE	FALSE
123	3.70	13.30	TRUE	FALSE	173	1.66	12.08	TRUE	FALSE
124	3.14	12.78	TRUE	FALSE	174	1.75	12.23	TRUE	FALSE
125	3.42	12.50	TRUE	FALSE	175	1.75	12.23	TRUE	FALSE
126	3.42	12.50	TRUE	FALSE	176	1.72	12.26	TRUE	FALSE
127	3.42	12.50	TRUE	FALSE	177	1.72	12.26	TRUE	FALSE
128	3.18	12.24	TRUE	FALSE	178	1.72	12.26	TRUE	FALSE
129	3.24	12.30	TRUE	FALSE	179	1.77	12.35	TRUE	FALSE
130	3.26	12.28	TRUE	FALSE	180	2.38	12.72	TRUE	FALSE
131	2.92	12.06	TRUE	FALSE	181	2.84	12.64	TRUE	FALSE
132	2.92	12.06	TRUE	FALSE	182	2.89	12.67	TRUE	FALSE
133	3.28	12.46	TRUE	FALSE	183	2.90	12.66	TRUE	FALSE
134	3.98	12.92	TRUE	FALSE	184	2.90	12.66	TRUE	FALSE
135	3.98	12.92	TRUE	FALSE	185	2.90	12.66	TRUE	FALSE
136	4.05	12.91	TRUE	FALSE	186	2.62	11.84	TRUE	FALSE
137	4.13	12.97	TRUE	FALSE	187	2.62	11.84	TRUE	FALSE
138	3.64	12.80	TRUE	FALSE	188	2.61	11.85	TRUE	FALSE
139	3.40	12.26	TRUE	FALSE	189	2.61	11.85	TRUE	FALSE
140	3.40	12.26	TRUE	FALSE	190	2.74	12.02	TRUE	FALSE
141	2.81	11.95	TRUE	FALSE	191	2.74	12.02	TRUE	FALSE
142	1.03	10.97	TRUE	FALSE	192	2.74	12.02	TRUE	FALSE
143	1.47	11.29	TRUE	FALSE	193	2.74	12.02	TRUE	FALSE
144	1.59	11.17	TRUE	FALSE	194	2.74	11.30	TRUE	FALSE
145	1.49	11.27	TRUE	FALSE	195	2.74	11.30	TRUE	FALSE
146	1.87	11.79	TRUE	FALSE	196	2.74	11.30	TRUE	FALSE
147	1.87	11.79	TRUE	FALSE	197	2.01	10.15	TRUE	FALSE
148	1.87	11.79	TRUE	FALSE	198	1.98	10.18	TRUE	FALSE
149	1.87	11.79	TRUE	FALSE	199	1.47	9.81	TRUE	FALSE
150	1.87	11.79	TRUE	FALSE	200	1.49	9.79	TRUE	FALSE

Table 48. Hsu's procedure results for six decision variables for mutation rate = 0.05

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	-7.08	14.02	FALSE	FALSE
2	-33.12	12.56	FALSE	FALSE	52	-6.59	12.39	FALSE	FALSE
3	-32.64	6.24	FALSE	FALSE	53	-7.10	11.76	FALSE	FALSE
4	-21.59	11.67	FALSE	FALSE	54	-6.90	11.56	FALSE	FALSE
5	-22.61	13.65	FALSE	FALSE	55	-7.44	11.36	FALSE	FALSE
6	-26.99	15.11	FALSE	FALSE	56	-8.03	10.47	FALSE	FALSE
7	-24.51	20.57	FALSE	FALSE	57	-6.94	11.02	FALSE	FALSE
8	-24.99	18.91	FALSE	FALSE	58	-4.63	12.33	FALSE	FALSE
9	-25.17	17.87	FALSE	FALSE	59	-5.37	12.13	FALSE	FALSE
10	-19.92	17.76	FALSE	FALSE	60	-5.39	11.69	FALSE	FALSE
11	-20.72	17.18	FALSE	FALSE	61	-5.50	9.02	FALSE	FALSE
12	-19.28	17.38	FALSE	FALSE	62	-7.10	7.10	FALSE	FALSE
13	-20.17	15.25	FALSE	FALSE	63	-7.98	6.18	FALSE	FALSE
14	-18.12	16.22	FALSE	FALSE	64	-8.00	6.14	FALSE	FALSE
15	-15.33	17.83	FALSE	FALSE	65	-8.08	6.22	FALSE	FALSE
16	-18.80	14.96	FALSE	FALSE	66	-8.21	5.85	FALSE	FALSE
17	-15.87	16.95	FALSE	FALSE	67	-8.62	5.44	FALSE	FALSE
18	-14.85	17.51	FALSE	FALSE	68	-8.73	5.19	FALSE	FALSE
19	-14.95	17.53	FALSE	FALSE	69	-7.97	5.93	FALSE	FALSE
20	-14.48	19.12	FALSE	FALSE	70	-8.73	5.31	FALSE	FALSE
21	-13.19	18.45	FALSE	FALSE	71	-8.58	5.18	FALSE	FALSE
22	-9.23	21.75	FALSE	FALSE	72	-8.50	5.22	FALSE	FALSE
23	-5.98	24.08	FALSE	FALSE	73	-8.60	5.14	FALSE	FALSE
24	-8.10	20.82	FALSE	FALSE	74	-9.10	4.72	FALSE	FALSE
25	-6.94	20.08	FALSE	FALSE	75	-9.20	4.82	FALSE	FALSE
26	-8.52	17.50	FALSE	FALSE	76	-10.47	2.73	FALSE	FALSE
27	-8.29	17.83	FALSE	FALSE	77	-10.46	2.72	FALSE	FALSE
28	-8.25	17.79	FALSE	FALSE	78	-10.46	2.80	FALSE	FALSE
29	-8.59	17.57	FALSE	FALSE	79	-10.46	2.80	FALSE	FALSE
30	-8.88	17.12	FALSE	FALSE	80	-10.52	2.76	FALSE	FALSE
31	-10.40	15.00	FALSE	FALSE	81	-10.48	2.72	FALSE	FALSE
32	-12.13	14.13	FALSE	FALSE	82	-10.57	2.05	FALSE	FALSE
33	-11.30	14.64	FALSE	FALSE	83	-10.60	2.04	FALSE	FALSE
34	-11.43	13.75	FALSE	FALSE	84	-10.60	2.04	FALSE	FALSE
35	-13.37	12.05	FALSE	FALSE	85	-10.39	1.83	FALSE	FALSE
36	-14.07	11.25	FALSE	FALSE	86	-10.43	1.63	FALSE	FALSE
37	-9.46	14.44	FALSE	FALSE	87	-10.43	1.63	FALSE	FALSE
38	-7.03	15.65	FALSE	FALSE	88	-11.70	0.08	FALSE	FALSE
39	-7.32	15.42	FALSE	FALSE	89	-11.17	0.49	FALSE	FALSE
40	-6.46	17.76	FALSE	FALSE	90	-11.17	0.49	FALSE	FALSE
41	-5.97	18.53	FALSE	FALSE	91	-11.17	0.49	FALSE	FALSE
42	-5.23	16.37	FALSE	FALSE	92	-10.93	0.25	FALSE	FALSE
43	-5.10	16.24	FALSE	FALSE	93	-10.88	0.20	FALSE	FALSE
44	-5.12	16.26	FALSE	FALSE	94	-11.03	0.35	FALSE	FALSE
45	-7.19	14.69	FALSE	FALSE	95	-10.52	0.30	FALSE	FALSE
46	-7.31	14.81	FALSE	FALSE	96	-10.52	0.30	FALSE	FALSE
47	-8.35	13.67	FALSE	FALSE	97	-10.64	0.02	FALSE	FALSE
48	-8.44	13.76	FALSE	FALSE	98	-10.64	0.02	FALSE	FALSE
49	-8.10	13.50	FALSE	FALSE	99	-11.14	-0.32	FALSE	TRUE
50	-7.05	14.07	FALSE	FALSE	100	-10.83	-0.45	FALSE	TRUE

Table 48. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	-10.83	-0.45	FALSE	TRUE	151	-9.22	0.92	FALSE	FALSE
102	-9.46	1.30	FALSE	FALSE	152	-9.21	0.91	FALSE	FALSE
103	-9.48	1.32	FALSE	FALSE	153	-9.44	0.46	FALSE	FALSE
104	-9.59	1.37	FALSE	FALSE	154	-9.40	0.52	FALSE	FALSE
105	-9.53	1.45	FALSE	FALSE	155	-8.98	0.94	FALSE	FALSE
106	-8.50	2.02	FALSE	FALSE	156	-8.98	0.94	FALSE	FALSE
107	-8.55	1.97	FALSE	FALSE	157	-9.04	0.78	FALSE	FALSE
108	-7.82	2.52	FALSE	FALSE	158	-8.97	0.81	FALSE	FALSE
109	-8.16	2.06	FALSE	FALSE	159	-9.04	0.88	FALSE	FALSE
110	-8.62	1.78	FALSE	FALSE	160	-9.08	0.86	FALSE	FALSE
111	-8.69	1.85	FALSE	FALSE	161	-9.08	0.86	FALSE	FALSE
112	-8.69	1.85	FALSE	FALSE	162	-9.14	0.92	FALSE	FALSE
113	-8.69	1.85	FALSE	FALSE	163	-9.13	0.91	FALSE	FALSE
114	-8.65	1.79	FALSE	FALSE	164	-9.02	1.10	FALSE	FALSE
115	-8.65	1.79	FALSE	FALSE	165	-9.03	1.11	FALSE	FALSE
116	-8.68	1.82	FALSE	FALSE	166	-9.03	1.11	FALSE	FALSE
117	-8.92	1.58	FALSE	FALSE	167	-9.45	0.69	FALSE	FALSE
118	-8.50	1.16	FALSE	FALSE	168	-9.45	0.69	FALSE	FALSE
119	-8.40	1.30	FALSE	FALSE	169	-9.78	0.46	FALSE	FALSE
120	-8.40	1.30	FALSE	FALSE	170	-9.87	0.55	FALSE	FALSE
121	-8.42	1.26	FALSE	FALSE	171	-9.87	0.55	FALSE	FALSE
122	-8.40	1.24	FALSE	FALSE	172	-9.87	0.55	FALSE	FALSE
123	-8.38	1.22	FALSE	FALSE	173	-9.87	0.55	FALSE	FALSE
124	-8.40	1.24	FALSE	FALSE	174	-10.02	0.46	FALSE	FALSE
125	-8.12	0.96	FALSE	FALSE	175	-10.02	0.46	FALSE	FALSE
126	-8.12	0.96	FALSE	FALSE	176	-9.72	0.82	FALSE	FALSE
127	-8.12	0.96	FALSE	FALSE	177	-9.72	0.82	FALSE	FALSE
128	-8.11	0.95	FALSE	FALSE	178	-9.72	0.82	FALSE	FALSE
129	-8.17	0.89	FALSE	FALSE	179	-9.81	0.77	FALSE	FALSE
130	-8.15	0.87	FALSE	FALSE	180	-9.84	0.50	FALSE	FALSE
131	-8.21	0.93	FALSE	FALSE	181	-9.95	-0.15	FALSE	TRUE
132	-8.21	0.93	FALSE	FALSE	182	-9.98	-0.20	FALSE	TRUE
133	-8.61	0.57	FALSE	FALSE	183	-9.97	-0.21	FALSE	TRUE
134	-8.51	0.43	FALSE	FALSE	184	-9.97	-0.21	FALSE	TRUE
135	-8.51	0.43	FALSE	FALSE	185	-9.97	-0.21	FALSE	TRUE
136	-8.67	0.19	FALSE	FALSE	186	-9.70	-0.48	FALSE	TRUE
137	-8.73	0.11	FALSE	FALSE	187	-9.70	-0.48	FALSE	TRUE
138	-8.83	0.33	FALSE	FALSE	188	-9.70	-0.46	FALSE	TRUE
139	-8.62	0.24	FALSE	FALSE	189	-9.70	-0.46	FALSE	TRUE
140	-8.62	0.24	FALSE	FALSE	190	-9.87	-0.59	FALSE	TRUE
141	-8.76	0.38	FALSE	FALSE	191	-9.87	-0.59	FALSE	TRUE
142	-9.10	0.84	FALSE	FALSE	192	-9.87	-0.59	FALSE	TRUE
143	-9.01	0.81	FALSE	FALSE	193	-9.84	-0.56	FALSE	TRUE
144	-8.89	0.69	FALSE	FALSE	194	-8.91	-0.35	FALSE	TRUE
145	-8.53	1.25	FALSE	FALSE	195	-8.91	-0.35	FALSE	TRUE
146	-9.11	0.81	FALSE	FALSE	196	-8.91	-0.35	FALSE	TRUE
147	-9.11	0.81	FALSE	FALSE	197	-8.58	-0.44	FALSE	TRUE
148	-9.11	0.81	FALSE	FALSE	198	-8.55	-0.35	FALSE	TRUE
149	-9.11	0.81	FALSE	FALSE	199	-8.62	-0.28	FALSE	TRUE
150	-9.11	0.81	FALSE	FALSE	200	-8.49	-0.19	FALSE	TRUE

Table 49. Hsu's procedure results for six decision variables for mutation rate = 0.07

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	-2.23	18.87	FALSE	FALSE
2	-3.36	42.32	FALSE	FALSE	52	-1.14	17.84	FALSE	FALSE
3	-6.24	32.64	FALSE	FALSE	53	-1.84	17.02	FALSE	FALSE
4	-3.90	29.36	FALSE	FALSE	54	-1.96	16.50	FALSE	FALSE
5	-0.30	35.96	FALSE	FALSE	55	-2.61	16.19	FALSE	FALSE
6	-14.65	27.45	FALSE	FALSE	56	-2.43	16.07	FALSE	FALSE
7	-17.20	27.88	FALSE	FALSE	57	-1.34	16.62	FALSE	FALSE
8	-18.91	24.99	FALSE	FALSE	58	1.50	18.46	TRUE	FALSE
9	-17.87	25.17	FALSE	FALSE	59	1.15	18.65	TRUE	FALSE
10	-17.76	19.92	FALSE	FALSE	60	0.41	17.49	TRUE	FALSE
11	-17.18	20.72	FALSE	FALSE	61	1.49	16.01	TRUE	FALSE
12	-17.38	19.28	FALSE	FALSE	62	0.56	14.76	TRUE	FALSE
13	-14.47	20.95	FALSE	FALSE	63	1.47	15.63	TRUE	FALSE
14	-15.62	18.72	FALSE	FALSE	64	1.51	15.65	TRUE	FALSE
15	-12.20	20.96	FALSE	FALSE	65	1.43	15.73	TRUE	FALSE
16	-10.25	23.51	FALSE	FALSE	66	1.80	15.86	TRUE	FALSE
17	-8.49	24.33	FALSE	FALSE	67	1.31	15.37	TRUE	FALSE
18	-7.57	24.79	FALSE	FALSE	68	0.23	14.15	TRUE	FALSE
19	-9.11	23.37	FALSE	FALSE	69	-0.48	13.42	FALSE	FALSE
20	-5.83	27.77	FALSE	FALSE	70	0.14	14.18	TRUE	FALSE
21	-3.72	27.92	FALSE	FALSE	71	0.20	13.96	TRUE	FALSE
22	-1.04	29.94	FALSE	FALSE	72	0.47	14.19	TRUE	FALSE
23	-0.04	30.02	FALSE	FALSE	73	0.81	14.55	TRUE	FALSE
24	-0.47	28.45	FALSE	FALSE	74	1.23	15.05	TRUE	FALSE
25	0.96	27.98	TRUE	FALSE	75	0.84	14.86	TRUE	FALSE
26	1.46	27.48	TRUE	FALSE	76	2.93	16.13	TRUE	FALSE
27	0.78	26.90	TRUE	FALSE	77	2.90	16.08	TRUE	FALSE
28	1.28	27.32	TRUE	FALSE	78	1.78	15.04	TRUE	FALSE
29	0.85	27.01	TRUE	FALSE	79	1.78	15.04	TRUE	FALSE
30	1.34	27.34	TRUE	FALSE	80	1.82	15.10	TRUE	FALSE
31	0.35	25.75	TRUE	FALSE	81	1.86	15.06	TRUE	FALSE
32	0.24	26.50	TRUE	FALSE	82	2.41	15.03	TRUE	FALSE
33	1.07	27.01	TRUE	FALSE	83	2.42	15.06	TRUE	FALSE
34	1.48	26.66	TRUE	FALSE	84	2.42	15.06	TRUE	FALSE
35	2.02	27.44	TRUE	FALSE	85	1.70	13.92	TRUE	FALSE
36	1.79	27.11	TRUE	FALSE	86	1.90	13.96	TRUE	FALSE
37	3.31	27.21	TRUE	FALSE	87	1.90	13.96	TRUE	FALSE
38	3.24	25.92	TRUE	FALSE	88	2.76	14.54	TRUE	FALSE
39	2.73	25.47	TRUE	FALSE	89	2.98	14.64	TRUE	FALSE
40	2.78	27.00	TRUE	FALSE	90	2.98	14.64	TRUE	FALSE
41	3.21	27.71	TRUE	FALSE	91	2.98	14.64	TRUE	FALSE
42	0.50	22.10	TRUE	FALSE	92	3.22	14.40	TRUE	FALSE
43	-0.16	21.18	FALSE	FALSE	93	3.20	14.28	TRUE	FALSE
44	-0.61	20.77	FALSE	FALSE	94	3.05	14.43	TRUE	FALSE
45	-0.86	21.02	FALSE	FALSE	95	3.65	14.47	TRUE	FALSE
46	-0.98	21.14	FALSE	FALSE	96	3.65	14.47	TRUE	FALSE
47	-1.65	20.37	FALSE	FALSE	97	3.93	14.59	TRUE	FALSE
48	-2.90	19.30	FALSE	FALSE	98	3.93	14.59	TRUE	FALSE
49	-2.93	18.67	FALSE	FALSE	99	4.27	15.09	TRUE	FALSE
50	-2.24	18.88	FALSE	FALSE	100	4.49	14.87	TRUE	FALSE

Table 49. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	4.49	14.87	TRUE	FALSE	151	4.46	14.60	TRUE	FALSE
102	4.30	15.06	TRUE	FALSE	152	4.28	14.40	TRUE	FALSE
103	4.28	15.08	TRUE	FALSE	153	4.58	14.48	TRUE	FALSE
104	4.23	15.19	TRUE	FALSE	154	4.42	14.34	TRUE	FALSE
105	4.22	15.20	TRUE	FALSE	155	4.42	14.34	TRUE	FALSE
106	4.45	14.97	TRUE	FALSE	156	4.42	14.34	TRUE	FALSE
107	4.50	15.02	TRUE	FALSE	157	4.42	14.24	TRUE	FALSE
108	4.59	14.93	TRUE	FALSE	158	4.19	13.97	TRUE	FALSE
109	5.05	15.27	TRUE	FALSE	159	3.60	13.52	TRUE	FALSE
110	5.33	15.73	TRUE	FALSE	160	3.62	13.56	TRUE	FALSE
111	5.09	15.63	TRUE	FALSE	161	3.62	13.56	TRUE	FALSE
112	5.09	15.63	TRUE	FALSE	162	3.46	13.52	TRUE	FALSE
113	5.09	15.63	TRUE	FALSE	163	3.30	13.34	TRUE	FALSE
114	5.29	15.73	TRUE	FALSE	164	3.12	13.24	TRUE	FALSE
115	5.29	15.73	TRUE	FALSE	165	2.79	12.93	TRUE	FALSE
116	5.17	15.67	TRUE	FALSE	166	2.79	12.93	TRUE	FALSE
117	5.41	15.91	TRUE	FALSE	167	3.21	13.35	TRUE	FALSE
118	5.15	14.81	TRUE	FALSE	168	3.21	13.35	TRUE	FALSE
119	5.13	14.83	TRUE	FALSE	169	3.44	13.68	TRUE	FALSE
120	5.13	14.83	TRUE	FALSE	170	3.12	13.54	TRUE	FALSE
121	5.17	14.85	TRUE	FALSE	171	3.12	13.54	TRUE	FALSE
122	5.19	14.83	TRUE	FALSE	172	3.12	13.54	TRUE	FALSE
123	5.21	14.81	TRUE	FALSE	173	3.12	13.54	TRUE	FALSE
124	5.19	14.83	TRUE	FALSE	174	3.21	13.69	TRUE	FALSE
125	4.64	13.72	TRUE	FALSE	175	3.21	13.69	TRUE	FALSE
126	4.64	13.72	TRUE	FALSE	176	3.18	13.72	TRUE	FALSE
127	4.64	13.72	TRUE	FALSE	177	3.18	13.72	TRUE	FALSE
128	4.65	13.71	TRUE	FALSE	178	3.18	13.72	TRUE	FALSE
129	4.71	13.77	TRUE	FALSE	179	3.23	13.81	TRUE	FALSE
130	4.39	13.41	TRUE	FALSE	180	3.84	14.18	TRUE	FALSE
131	4.33	13.47	TRUE	FALSE	181	4.22	14.02	TRUE	FALSE
132	4.33	13.47	TRUE	FALSE	182	4.27	14.05	TRUE	FALSE
133	4.69	13.87	TRUE	FALSE	183	4.25	14.01	TRUE	FALSE
134	5.39	14.33	TRUE	FALSE	184	3.96	13.72	TRUE	FALSE
135	5.39	14.33	TRUE	FALSE	185	3.96	13.72	TRUE	FALSE
136	5.22	14.08	TRUE	FALSE	186	3.60	12.82	TRUE	FALSE
137	5.30	14.14	TRUE	FALSE	187	3.60	12.82	TRUE	FALSE
138	5.14	14.30	TRUE	FALSE	188	3.29	12.53	TRUE	FALSE
139	5.29	14.15	TRUE	FALSE	189	3.29	12.53	TRUE	FALSE
140	5.12	13.98	TRUE	FALSE	190	3.42	12.70	TRUE	FALSE
141	4.87	14.01	TRUE	FALSE	191	3.42	12.70	TRUE	FALSE
142	4.02	13.96	TRUE	FALSE	192	3.42	12.70	TRUE	FALSE
143	4.32	14.14	TRUE	FALSE	193	3.42	12.70	TRUE	FALSE
144	4.25	13.83	TRUE	FALSE	194	3.78	12.34	TRUE	FALSE
145	4.15	13.93	TRUE	FALSE	195	3.78	12.34	TRUE	FALSE
146	4.59	14.51	TRUE	FALSE	196	3.78	12.34	TRUE	FALSE
147	4.59	14.51	TRUE	FALSE	197	3.99	12.13	TRUE	FALSE
148	4.59	14.51	TRUE	FALSE	198	3.76	11.96	TRUE	FALSE
149	4.59	14.51	TRUE	FALSE	199	3.69	12.03	TRUE	FALSE
150	4.59	14.51	TRUE	FALSE	200	3.71	12.01	TRUE	FALSE

Table 50. Hsu's procedure results for six decision variables for mutation rate = 0.10

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
1	-23.67	23.67	FALSE	FALSE	51	-14.02	7.08	FALSE	FALSE
2	-4.16	41.52	FALSE	FALSE	52	-12.39	6.59	FALSE	FALSE
3	-4.35	34.53	FALSE	FALSE	53	-11.76	7.10	FALSE	FALSE
4	-11.67	21.59	FALSE	FALSE	54	-11.56	6.90	FALSE	FALSE
5	-7.34	28.92	FALSE	FALSE	55	-11.36	7.44	FALSE	FALSE
6	-15.11	26.99	FALSE	FALSE	56	-10.47	8.03	FALSE	FALSE
7	-20.57	24.51	FALSE	FALSE	57	-11.02	6.94	FALSE	FALSE
8	-16.80	27.10	FALSE	FALSE	58	-12.33	4.63	FALSE	FALSE
9	-17.48	25.56	FALSE	FALSE	59	-12.13	5.37	FALSE	FALSE
10	-13.36	24.32	FALSE	FALSE	60	-11.69	5.39	FALSE	FALSE
11	-16.84	21.06	FALSE	FALSE	61	-9.02	5.50	FALSE	FALSE
12	-14.84	21.82	FALSE	FALSE	62	-7.10	7.10	FALSE	FALSE
13	-15.25	20.17	FALSE	FALSE	63	-6.18	7.98	FALSE	FALSE
14	-14.87	19.47	FALSE	FALSE	64	-6.14	8.00	FALSE	FALSE
15	-17.83	15.33	FALSE	FALSE	65	-6.22	8.08	FALSE	FALSE
16	-14.96	18.80	FALSE	FALSE	66	-5.85	8.21	FALSE	FALSE
17	-16.95	15.87	FALSE	FALSE	67	-5.44	8.62	FALSE	FALSE
18	-17.51	14.85	FALSE	FALSE	68	-5.19	8.73	FALSE	FALSE
19	-17.53	14.95	FALSE	FALSE	69	-5.93	7.97	FALSE	FALSE
20	-19.12	14.48	FALSE	FALSE	70	-5.31	8.73	FALSE	FALSE
21	-18.45	13.19	FALSE	FALSE	71	-5.18	8.58	FALSE	FALSE
22	-21.75	9.23	FALSE	FALSE	72	-5.22	8.50	FALSE	FALSE
23	-24.08	5.98	FALSE	FALSE	73	-5.14	8.60	FALSE	FALSE
24	-20.82	8.10	FALSE	FALSE	74	-4.72	9.10	FALSE	FALSE
25	-20.08	6.94	FALSE	FALSE	75	-4.82	9.20	FALSE	FALSE
26	-17.50	8.52	FALSE	FALSE	76	-2.73	10.47	FALSE	FALSE
27	-17.83	8.29	FALSE	FALSE	77	-2.72	10.46	FALSE	FALSE
28	-17.79	8.25	FALSE	FALSE	78	-2.80	10.46	FALSE	FALSE
29	-17.57	8.59	FALSE	FALSE	79	-2.80	10.46	FALSE	FALSE
30	-17.12	8.88	FALSE	FALSE	80	-2.76	10.52	FALSE	FALSE
31	-15.00	10.40	FALSE	FALSE	81	-2.72	10.48	FALSE	FALSE
32	-14.13	12.13	FALSE	FALSE	82	-2.05	10.57	FALSE	FALSE
33	-14.64	11.30	FALSE	FALSE	83	-2.04	10.60	FALSE	FALSE
34	-13.75	11.43	FALSE	FALSE	84	-2.04	10.60	FALSE	FALSE
35	-12.05	13.37	FALSE	FALSE	85	-1.83	10.39	FALSE	FALSE
36	-11.25	14.07	FALSE	FALSE	86	-1.63	10.43	FALSE	FALSE
37	-14.44	9.46	FALSE	FALSE	87	-1.63	10.43	FALSE	FALSE
38	-15.65	7.03	FALSE	FALSE	88	-0.08	11.70	FALSE	FALSE
39	-15.42	7.32	FALSE	FALSE	89	-0.49	11.17	FALSE	FALSE
40	-17.76	6.46	FALSE	FALSE	90	-0.49	11.17	FALSE	FALSE
41	-18.53	5.97	FALSE	FALSE	91	-0.49	11.17	FALSE	FALSE
42	-16.37	5.23	FALSE	FALSE	92	-0.25	10.93	FALSE	FALSE
43	-16.24	5.10	FALSE	FALSE	93	-0.20	10.88	FALSE	FALSE
44	-16.26	5.12	FALSE	FALSE	94	-0.35	11.03	FALSE	FALSE
45	-14.69	7.19	FALSE	FALSE	95	-0.30	10.52	FALSE	FALSE
46	-14.81	7.31	FALSE	FALSE	96	-0.30	10.52	FALSE	FALSE
47	-13.67	8.35	FALSE	FALSE	97	-0.02	10.64	FALSE	FALSE
48	-13.76	8.44	FALSE	FALSE	98	-0.02	10.64	FALSE	FALSE
49	-13.50	8.10	FALSE	FALSE	99	0.32	11.14	TRUE	FALSE
50	-14.07	7.05	FALSE	FALSE	100	0.45	10.83	TRUE	FALSE

Table 50. (Continued)

Gen.	D-M	D+M	Not Best	Is Best	Gen.	D-M	D+M	Not Best	Is Best
101	0.45	10.83	TRUE	FALSE	151	-0.92	9.22	FALSE	FALSE
102	-1.30	9.46	FALSE	FALSE	152	-0.91	9.21	FALSE	FALSE
103	-1.32	9.48	FALSE	FALSE	153	-0.46	9.44	FALSE	FALSE
104	-1.37	9.59	FALSE	FALSE	154	-0.52	9.40	FALSE	FALSE
105	-1.45	9.53	FALSE	FALSE	155	-0.94	8.98	FALSE	FALSE
106	-2.02	8.50	FALSE	FALSE	156	-0.94	8.98	FALSE	FALSE
107	-1.97	8.55	FALSE	FALSE	157	-0.78	9.04	FALSE	FALSE
108	-2.52	7.82	FALSE	FALSE	158	-0.81	8.97	FALSE	FALSE
109	-2.06	8.16	FALSE	FALSE	159	-0.88	9.04	FALSE	FALSE
110	-1.78	8.62	FALSE	FALSE	160	-0.86	9.08	FALSE	FALSE
111	-1.85	8.69	FALSE	FALSE	161	-0.86	9.08	FALSE	FALSE
112	-1.85	8.69	FALSE	FALSE	162	-0.92	9.14	FALSE	FALSE
113	-1.85	8.69	FALSE	FALSE	163	-0.91	9.13	FALSE	FALSE
114	-1.79	8.65	FALSE	FALSE	164	-1.10	9.02	FALSE	FALSE
115	-1.79	8.65	FALSE	FALSE	165	-1.11	9.03	FALSE	FALSE
116	-1.82	8.68	FALSE	FALSE	166	-1.11	9.03	FALSE	FALSE
117	-1.58	8.92	FALSE	FALSE	167	-0.69	9.45	FALSE	FALSE
118	-1.16	8.50	FALSE	FALSE	168	-0.69	9.45	FALSE	FALSE
119	-1.30	8.40	FALSE	FALSE	169	-0.46	9.78	FALSE	FALSE
120	-1.30	8.40	FALSE	FALSE	170	-0.55	9.87	FALSE	FALSE
121	-1.26	8.42	FALSE	FALSE	171	-0.55	9.87	FALSE	FALSE
122	-1.24	8.40	FALSE	FALSE	172	-0.55	9.87	FALSE	FALSE
123	-1.22	8.38	FALSE	FALSE	173	-0.55	9.87	FALSE	FALSE
124	-1.24	8.40	FALSE	FALSE	174	-0.46	10.02	FALSE	FALSE
125	-0.96	8.12	FALSE	FALSE	175	-0.46	10.02	FALSE	FALSE
126	-0.96	8.12	FALSE	FALSE	176	-0.82	9.72	FALSE	FALSE
127	-0.96	8.12	FALSE	FALSE	177	-0.82	9.72	FALSE	FALSE
128	-0.95	8.11	FALSE	FALSE	178	-0.82	9.72	FALSE	FALSE
129	-0.89	8.17	FALSE	FALSE	179	-0.77	9.81	FALSE	FALSE
130	-0.87	8.15	FALSE	FALSE	180	-0.50	9.84	FALSE	FALSE
131	-0.93	8.21	FALSE	FALSE	181	0.15	9.95	TRUE	FALSE
132	-0.93	8.21	FALSE	FALSE	182	0.20	9.98	TRUE	FALSE
133	-0.57	8.61	FALSE	FALSE	183	0.21	9.97	TRUE	FALSE
134	-0.43	8.51	FALSE	FALSE	184	0.21	9.97	TRUE	FALSE
135	-0.43	8.51	FALSE	FALSE	185	0.21	9.97	TRUE	FALSE
136	-0.19	8.67	FALSE	FALSE	186	0.48	9.70	TRUE	FALSE
137	-0.11	8.73	FALSE	FALSE	187	0.48	9.70	TRUE	FALSE
138	-0.33	8.83	FALSE	FALSE	188	0.46	9.70	TRUE	FALSE
139	-0.24	8.62	FALSE	FALSE	189	0.46	9.70	TRUE	FALSE
140	-0.24	8.62	FALSE	FALSE	190	0.59	9.87	TRUE	FALSE
141	-0.38	8.76	FALSE	FALSE	191	0.59	9.87	TRUE	FALSE
142	-0.84	9.10	FALSE	FALSE	192	0.59	9.87	TRUE	FALSE
143	-0.81	9.01	FALSE	FALSE	193	0.56	9.84	TRUE	FALSE
144	-0.69	8.89	FALSE	FALSE	194	0.35	8.91	TRUE	FALSE
145	-1.25	8.53	FALSE	FALSE	195	0.35	8.91	TRUE	FALSE
146	-0.81	9.11	FALSE	FALSE	196	0.35	8.91	TRUE	FALSE
147	-0.81	9.11	FALSE	FALSE	197	0.44	8.58	TRUE	FALSE
148	-0.81	9.11	FALSE	FALSE	198	0.35	8.55	TRUE	FALSE
149	-0.81	9.11	FALSE	FALSE	199	0.28	8.62	TRUE	FALSE
150	-0.81	9.11	FALSE	FALSE	200	0.19	8.49	TRUE	FALSE

APPENDIX E

Table 51. Kruskal-Wallis tests result for two decision variable case on population size

Gen.	Xkw	Critical Value	Conclusion	Gen.	Xkw	Critical Value	Conclusion
1	4.02	0.71	REJECT	51	4.72	0.71	REJECT
2	4.19	0.71	REJECT	52	4.70	0.71	REJECT
3	4.55	0.71	REJECT	53	4.70	0.71	REJECT
4	4.28	0.71	REJECT	54	4.94	0.71	REJECT
5	2.83	0.71	REJECT	55	5.00	0.71	REJECT
6	3.91	0.71	REJECT	56	5.00	0.71	REJECT
7	4.31	0.71	REJECT	57	5.00	0.71	REJECT
8	3.92	0.71	REJECT	58	5.00	0.71	REJECT
9	3.98	0.71	REJECT	59	5.00	0.71	REJECT
10	3.99	0.71	REJECT	60	5.00	0.71	REJECT
11	3.92	0.71	REJECT	61	5.00	0.71	REJECT
12	4.01	0.71	REJECT	62	4.90	0.71	REJECT
13	4.17	0.71	REJECT	63	4.90	0.71	REJECT
14	4.24	0.71	REJECT	64	4.98	0.71	REJECT
15	4.24	0.71	REJECT	65	5.09	0.71	REJECT
16	4.38	0.71	REJECT	66	5.09	0.71	REJECT
17	4.38	0.71	REJECT	67	5.09	0.71	REJECT
18	4.38	0.71	REJECT	68	5.09	0.71	REJECT
19	4.38	0.71	REJECT	69	5.09	0.71	REJECT
20	4.38	0.71	REJECT	70	5.09	0.71	REJECT
21	4.38	0.71	REJECT	71	5.09	0.71	REJECT
22	4.12	0.71	REJECT	72	5.08	0.71	REJECT
23	4.39	0.71	REJECT	73	5.08	0.71	REJECT
24	4.39	0.71	REJECT	74	5.08	0.71	REJECT
25	4.39	0.71	REJECT	75	5.08	0.71	REJECT
26	4.39	0.71	REJECT	76	5.08	0.71	REJECT
27	4.55	0.71	REJECT	77	5.08	0.71	REJECT
28	4.55	0.71	REJECT	78	5.08	0.71	REJECT
29	4.78	0.71	REJECT	79	5.08	0.71	REJECT
30	4.78	0.71	REJECT	80	5.08	0.71	REJECT
31	4.78	0.71	REJECT	81	5.08	0.71	REJECT
32	4.38	0.71	REJECT	82	5.08	0.71	REJECT
33	4.38	0.71	REJECT	83	5.08	0.71	REJECT
34	4.38	0.71	REJECT	84	5.22	0.71	REJECT
35	4.38	0.71	REJECT	85	5.68	0.71	REJECT
36	4.57	0.71	REJECT	86	5.68	0.71	REJECT
37	4.57	0.71	REJECT	87	5.68	0.71	REJECT
38	4.57	0.71	REJECT	88	5.68	0.71	REJECT
39	4.57	0.71	REJECT	89	5.68	0.71	REJECT
40	4.85	0.71	REJECT	90	5.55	0.71	REJECT
41	4.85	0.71	REJECT	91	5.55	0.71	REJECT
42	4.85	0.71	REJECT	92	5.55	0.71	REJECT
43	4.85	0.71	REJECT	93	5.55	0.71	REJECT
44	4.71	0.71	REJECT	94	5.55	0.71	REJECT
45	4.71	0.71	REJECT	95	5.55	0.71	REJECT
46	4.71	0.71	REJECT	96	5.55	0.71	REJECT
47	4.71	0.71	REJECT	97	5.55	0.71	REJECT
48	4.71	0.71	REJECT	98	5.51	0.71	REJECT
49	4.68	0.71	REJECT	99	5.51	0.71	REJECT
50	4.68	0.71	REJECT	100	5.51	0.71	REJECT

Table 52. Kruskal-Wallis tests result for six decision variable case on population size

Gen.	Xkw	Critical Value	Conclusion	Gen.	Xkw	Critical Value	Conclusion
1	5.30	0.71	REJECT	51	6.25	0.71	REJECT
2	6.14	0.71	REJECT	52	6.23	0.71	REJECT
3	4.81	0.71	REJECT	53	6.23	0.71	REJECT
4	4.86	0.71	REJECT	54	6.21	0.71	REJECT
5	5.17	0.71	REJECT	55	6.21	0.71	REJECT
6	4.76	0.71	REJECT	56	6.19	0.71	REJECT
7	5.03	0.71	REJECT	57	6.34	0.71	REJECT
8	4.62	0.71	REJECT	58	6.50	0.71	REJECT
9	4.57	0.71	REJECT	59	6.52	0.71	REJECT
10	4.60	0.71	REJECT	60	6.44	0.71	REJECT
11	4.79	0.71	REJECT	61	6.60	0.71	REJECT
12	5.08	0.71	REJECT	62	6.60	0.71	REJECT
13	4.84	0.71	REJECT	63	6.47	0.71	REJECT
14	5.19	0.71	REJECT	64	6.55	0.71	REJECT
15	5.80	0.71	REJECT	65	6.28	0.71	REJECT
16	5.75	0.71	REJECT	66	6.24	0.71	REJECT
17	5.87	0.71	REJECT	67	6.00	0.71	REJECT
18	5.57	0.71	REJECT	68	5.98	0.71	REJECT
19	5.75	0.71	REJECT	69	5.44	0.71	REJECT
20	5.89	0.71	REJECT	70	5.36	0.71	REJECT
21	5.84	0.71	REJECT	71	5.48	0.71	REJECT
22	5.68	0.71	REJECT	72	5.39	0.71	REJECT
23	5.66	0.71	REJECT	73	5.43	0.71	REJECT
24	5.58	0.71	REJECT	74	5.46	0.71	REJECT
25	5.63	0.71	REJECT	75	4.87	0.71	REJECT
26	5.55	0.71	REJECT	76	4.94	0.71	REJECT
27	5.61	0.71	REJECT	77	4.96	0.71	REJECT
28	5.61	0.71	REJECT	78	4.91	0.71	REJECT
29	5.64	0.71	REJECT	79	4.91	0.71	REJECT
30	5.63	0.71	REJECT	80	4.98	0.71	REJECT
31	5.58	0.71	REJECT	81	5.19	0.71	REJECT
32	5.75	0.71	REJECT	82	5.26	0.71	REJECT
33	5.77	0.71	REJECT	83	5.26	0.71	REJECT
34	5.69	0.71	REJECT	84	5.26	0.71	REJECT
35	5.69	0.71	REJECT	85	5.30	0.71	REJECT
36	5.84	0.71	REJECT	86	5.35	0.71	REJECT
37	5.92	0.71	REJECT	87	5.24	0.71	REJECT
38	5.94	0.71	REJECT	88	4.81	0.71	REJECT
39	5.94	0.71	REJECT	89	4.81	0.71	REJECT
40	5.89	0.71	REJECT	90	4.81	0.71	REJECT
41	5.90	0.71	REJECT	91	4.78	0.71	REJECT
42	5.77	0.71	REJECT	92	4.84	0.71	REJECT
43	5.86	0.71	REJECT	93	4.86	0.71	REJECT
44	5.94	0.71	REJECT	94	4.98	0.71	REJECT
45	6.09	0.71	REJECT	95	4.98	0.71	REJECT
46	6.28	0.71	REJECT	96	4.95	0.71	REJECT
47	6.40	0.71	REJECT	97	5.03	0.71	REJECT
48	6.48	0.71	REJECT	98	5.03	0.71	REJECT
49	6.43	0.71	REJECT	99	4.95	0.71	REJECT
50	6.25	0.71	REJECT	100	5.03	0.71	REJECT

Table 53. Results of multiple pair wise comparisons for two decision variable case

Between population size = 5 and 10							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-10.40	26.20	FALSE	51	-14.90	21.70	FALSE
2	-10.80	25.80	FALSE	52	-14.80	21.80	FALSE
3	-10.80	25.80	FALSE	53	-14.80	21.80	FALSE
4	-11.00	25.60	FALSE	54	-14.70	21.90	FALSE
5	-17.00	19.60	FALSE	55	-14.80	21.80	FALSE
6	-16.80	19.80	FALSE	56	-14.80	21.80	FALSE
7	-17.80	18.80	FALSE	57	-14.80	21.80	FALSE
8	-18.50	18.10	FALSE	58	-14.80	21.80	FALSE
9	-18.10	18.50	FALSE	59	-14.80	21.80	FALSE
10	-18.30	18.30	FALSE	60	-14.80	21.80	FALSE
11	-18.30	18.30	FALSE	61	-14.80	21.80	FALSE
12	-18.10	18.50	FALSE	62	-14.10	22.50	FALSE
13	-18.00	18.60	FALSE	63	-14.10	22.50	FALSE
14	-18.00	18.60	FALSE	64	-14.30	22.30	FALSE
15	-18.00	18.60	FALSE	65	-14.30	22.30	FALSE
16	-15.60	21.00	FALSE	66	-14.30	22.30	FALSE
17	-15.60	21.00	FALSE	67	-14.30	22.30	FALSE
18	-15.60	21.00	FALSE	68	-14.30	22.30	FALSE
19	-15.60	21.00	FALSE	69	-14.30	22.30	FALSE
20	-15.60	21.00	FALSE	70	-14.30	22.30	FALSE
21	-15.60	21.00	FALSE	71	-14.30	22.30	FALSE
22	-14.20	22.40	FALSE	72	-14.50	22.10	FALSE
23	-14.20	22.40	FALSE	73	-14.50	22.10	FALSE
24	-14.20	22.40	FALSE	74	-14.50	22.10	FALSE
25	-14.20	22.40	FALSE	75	-14.50	22.10	FALSE
26	-14.20	22.40	FALSE	76	-14.50	22.10	FALSE
27	-14.70	21.90	FALSE	77	-14.50	22.10	FALSE
28	-14.70	21.90	FALSE	78	-14.50	22.10	FALSE
29	-14.60	22.00	FALSE	79	-14.50	22.10	FALSE
30	-14.60	22.00	FALSE	80	-14.50	22.10	FALSE
31	-14.60	22.00	FALSE	81	-14.50	22.10	FALSE
32	-12.50	24.10	FALSE	82	-14.50	22.10	FALSE
33	-12.50	24.10	FALSE	83	-14.50	22.10	FALSE
34	-12.50	24.10	FALSE	84	-14.60	22.00	FALSE
35	-12.50	24.10	FALSE	85	-14.90	21.70	FALSE
36	-12.60	24.00	FALSE	86	-14.90	21.70	FALSE
37	-12.60	24.00	FALSE	87	-15.00	21.60	FALSE
38	-12.60	24.00	FALSE	88	-15.00	21.60	FALSE
39	-12.60	24.00	FALSE	89	-15.00	21.60	FALSE
40	-12.80	23.80	FALSE	90	-16.40	20.20	FALSE
41	-12.80	23.80	FALSE	91	-16.40	20.20	FALSE
42	-12.80	23.80	FALSE	92	-16.40	20.20	FALSE
43	-12.80	23.80	FALSE	93	-16.40	20.20	FALSE
44	-14.30	22.30	FALSE	94	-16.40	20.20	FALSE
45	-14.30	22.30	FALSE	95	-16.40	20.20	FALSE
46	-14.30	22.30	FALSE	96	-16.40	20.20	FALSE
47	-14.30	22.30	FALSE	97	-16.40	20.20	FALSE
48	-14.30	22.30	FALSE	98	-15.50	21.10	FALSE
49	-14.80	21.80	FALSE	99	-15.50	21.10	FALSE
50	-14.80	21.80	FALSE	100	-15.50	21.10	FALSE

Table 53. (Continued)

Between population size = 5 and 20							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-5.20	31.40	FALSE	51	-4.90	31.70	FALSE
2	-2.90	33.70	FALSE	52	-5.00	31.60	FALSE
3	-3.90	32.70	FALSE	53	-5.00	31.60	FALSE
4	-6.00	30.60	FALSE	54	-5.30	31.30	FALSE
5	-6.30	30.30	FALSE	55	-5.60	31.00	FALSE
6	-4.60	32.00	FALSE	56	-5.60	31.00	FALSE
7	-5.30	31.30	FALSE	57	-5.60	31.00	FALSE
8	-7.30	29.30	FALSE	58	-5.60	31.00	FALSE
9	-7.00	29.60	FALSE	59	-5.60	31.00	FALSE
10	-4.00	32.60	FALSE	60	-5.60	31.00	FALSE
11	-3.40	33.20	FALSE	61	-5.60	31.00	FALSE
12	-3.70	32.90	FALSE	62	-4.10	32.50	FALSE
13	-4.00	32.60	FALSE	63	-4.10	32.50	FALSE
14	-4.20	32.40	FALSE	64	-3.60	33.00	FALSE
15	-4.20	32.40	FALSE	65	-3.80	32.80	FALSE
16	-4.00	32.60	FALSE	66	-3.80	32.80	FALSE
17	-4.00	32.60	FALSE	67	-3.80	32.80	FALSE
18	-4.00	32.60	FALSE	68	-3.80	32.80	FALSE
19	-4.00	32.60	FALSE	69	-3.80	32.80	FALSE
20	-4.00	32.60	FALSE	70	-3.80	32.80	FALSE
21	-4.00	32.60	FALSE	71	-3.80	32.80	FALSE
22	-4.20	32.40	FALSE	72	-3.90	32.70	FALSE
23	-4.50	32.10	FALSE	73	-3.90	32.70	FALSE
24	-4.50	32.10	FALSE	74	-3.90	32.70	FALSE
25	-4.50	32.10	FALSE	75	-3.90	32.70	FALSE
26	-4.50	32.10	FALSE	76	-3.90	32.70	FALSE
27	-2.40	34.20	FALSE	77	-3.90	32.70	FALSE
28	-2.40	34.20	FALSE	78	-3.90	32.70	FALSE
29	-2.40	34.20	FALSE	79	-3.90	32.70	FALSE
30	-2.40	34.20	FALSE	80	-3.90	32.70	FALSE
31	-2.40	34.20	FALSE	81	-3.90	32.70	FALSE
32	-2.50	34.10	FALSE	82	-3.90	32.70	FALSE
33	-2.50	34.10	FALSE	83	-3.90	32.70	FALSE
34	-2.50	34.10	FALSE	84	-4.20	32.40	FALSE
35	-2.50	34.10	FALSE	85	-4.20	32.40	FALSE
36	-2.60	34.00	FALSE	86	-4.20	32.40	FALSE
37	-2.60	34.00	FALSE	87	-4.00	32.60	FALSE
38	-2.60	34.00	FALSE	88	-4.00	32.60	FALSE
39	-2.60	34.00	FALSE	89	-4.00	32.60	FALSE
40	-3.10	33.50	FALSE	90	-5.20	31.40	FALSE
41	-3.10	33.50	FALSE	91	-5.20	31.40	FALSE
42	-3.10	33.50	FALSE	92	-5.20	31.40	FALSE
43	-3.10	33.50	FALSE	93	-5.20	31.40	FALSE
44	-4.20	32.40	FALSE	94	-5.20	31.40	FALSE
45	-4.20	32.40	FALSE	95	-5.20	31.40	FALSE
46	-4.20	32.40	FALSE	96	-5.20	31.40	FALSE
47	-4.20	32.40	FALSE	97	-5.20	31.40	FALSE
48	-4.20	32.40	FALSE	98	-5.20	31.40	FALSE
49	-4.60	32.00	FALSE	99	-5.20	31.40	FALSE
50	-4.60	32.00	FALSE	100	-5.20	31.40	FALSE

Table 53. (Continued)

Between population size = 5 and 50							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	2.70	39.30	TRUE	51	2.40	39.00	TRUE
2	2.90	39.50	TRUE	52	2.40	39.00	TRUE
3	7.20	43.80	TRUE	53	2.40	39.00	TRUE
4	6.90	43.50	TRUE	54	4.00	40.60	TRUE
5	0.50	37.10	TRUE	55	4.60	41.20	TRUE
6	0.00	36.60	TRUE	56	4.60	41.20	TRUE
7	-0.60	36.00	FALSE	57	4.60	41.20	TRUE
8	-1.20	35.40	FALSE	58	4.60	41.20	TRUE
9	-0.70	35.90	FALSE	59	4.60	41.20	TRUE
10	-1.20	35.40	FALSE	60	4.60	41.20	TRUE
11	-1.40	35.20	FALSE	61	4.60	41.20	TRUE
12	0.50	37.10	TRUE	62	5.20	41.80	TRUE
13	0.10	36.70	TRUE	63	5.20	41.80	TRUE
14	-0.20	36.40	FALSE	64	5.30	41.90	TRUE
15	-0.20	36.40	FALSE	65	6.20	42.80	TRUE
16	-0.10	36.50	FALSE	66	6.20	42.80	TRUE
17	-0.10	36.50	FALSE	67	6.20	42.80	TRUE
18	-0.10	36.50	FALSE	68	6.20	42.80	TRUE
19	-0.10	36.50	FALSE	69	6.20	42.80	TRUE
20	-0.10	36.50	FALSE	70	6.20	42.80	TRUE
21	-0.10	36.50	FALSE	71	6.20	42.80	TRUE
22	-0.20	36.40	FALSE	72	6.10	42.70	TRUE
23	-0.60	36.00	FALSE	73	6.10	42.70	TRUE
24	-0.60	36.00	FALSE	74	6.10	42.70	TRUE
25	-0.60	36.00	FALSE	75	6.10	42.70	TRUE
26	-0.60	36.00	FALSE	76	6.10	42.70	TRUE
27	-0.80	35.80	FALSE	77	6.10	42.70	TRUE
28	-0.80	35.80	FALSE	78	6.10	42.70	TRUE
29	-0.80	35.80	FALSE	79	6.10	42.70	TRUE
30	-0.80	35.80	FALSE	80	6.10	42.70	TRUE
31	-0.80	35.80	FALSE	81	6.10	42.70	TRUE
32	-1.10	35.50	FALSE	82	6.10	42.70	TRUE
33	-1.10	35.50	FALSE	83	6.10	42.70	TRUE
34	-1.10	35.50	FALSE	84	5.70	42.30	TRUE
35	-1.10	35.50	FALSE	85	5.00	41.60	TRUE
36	0.30	36.90	TRUE	86	5.00	41.60	TRUE
37	0.30	36.90	TRUE	87	4.90	41.50	TRUE
38	0.30	36.90	TRUE	88	4.90	41.50	TRUE
39	0.30	36.90	TRUE	89	4.90	41.50	TRUE
40	3.10	39.70	TRUE	90	3.90	40.50	TRUE
41	3.10	39.70	TRUE	91	3.90	40.50	TRUE
42	3.10	39.70	TRUE	92	3.90	40.50	TRUE
43	3.10	39.70	TRUE	93	3.90	40.50	TRUE
44	2.10	38.70	TRUE	94	3.90	40.50	TRUE
45	2.10	38.70	TRUE	95	3.90	40.50	TRUE
46	2.10	38.70	TRUE	96	3.90	40.50	TRUE
47	2.10	38.70	TRUE	97	3.90	40.50	TRUE
48	2.10	38.70	TRUE	98	4.20	40.80	TRUE
49	1.80	38.40	TRUE	99	4.20	40.80	TRUE
50	1.80	38.40	TRUE	100	4.20	40.80	TRUE

Table 53. (Continued)

Between population size = 5 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	9.20	45.80	TRUE	51	9.70	46.30	TRUE
2	9.60	46.20	TRUE	52	9.70	46.30	TRUE
3	8.30	44.90	TRUE	53	9.70	46.30	TRUE
4	6.90	43.50	TRUE	54	9.80	46.40	TRUE
5	0.10	36.70	TRUE	55	9.60	46.20	TRUE
6	6.20	42.80	TRUE	56	9.60	46.20	TRUE
7	7.50	44.10	TRUE	57	9.60	46.20	TRUE
8	5.80	42.40	TRUE	58	9.60	46.20	TRUE
9	6.10	42.70	TRUE	59	9.60	46.20	TRUE
10	5.80	42.40	TRUE	60	9.60	46.20	TRUE
11	5.40	42.00	TRUE	61	9.60	46.20	TRUE
12	5.10	41.70	TRUE	62	9.30	45.90	TRUE
13	6.20	42.80	TRUE	63	9.30	45.90	TRUE
14	6.70	43.30	TRUE	64	9.40	46.00	TRUE
15	6.70	43.30	TRUE	65	9.20	45.80	TRUE
16	9.00	45.60	TRUE	66	9.20	45.80	TRUE
17	9.00	45.60	TRUE	67	9.20	45.80	TRUE
18	9.00	45.60	TRUE	68	9.20	45.80	TRUE
19	9.00	45.60	TRUE	69	9.20	45.80	TRUE
20	9.00	45.60	TRUE	70	9.20	45.80	TRUE
21	9.00	45.60	TRUE	71	9.20	45.80	TRUE
22	8.90	45.50	TRUE	72	9.10	45.70	TRUE
23	10.10	46.70	TRUE	73	9.10	45.70	TRUE
24	10.10	46.70	TRUE	74	9.10	45.70	TRUE
25	10.10	46.70	TRUE	75	9.10	45.70	TRUE
26	10.10	46.70	TRUE	76	9.10	45.70	TRUE
27	10.20	46.80	TRUE	77	9.10	45.70	TRUE
28	10.20	46.80	TRUE	78	9.10	45.70	TRUE
29	11.10	47.70	TRUE	79	9.10	45.70	TRUE
30	11.10	47.70	TRUE	80	9.10	45.70	TRUE
31	11.10	47.70	TRUE	81	9.10	45.70	TRUE
32	10.90	47.50	TRUE	82	9.10	45.70	TRUE
33	10.90	47.50	TRUE	83	9.10	45.70	TRUE
34	10.90	47.50	TRUE	84	9.90	46.50	TRUE
35	10.90	47.50	TRUE	85	11.90	48.50	TRUE
36	11.20	47.80	TRUE	86	11.90	48.50	TRUE
37	11.20	47.80	TRUE	87	11.90	48.50	TRUE
38	11.20	47.80	TRUE	88	11.90	48.50	TRUE
39	11.20	47.80	TRUE	89	11.90	48.50	TRUE
40	11.10	47.70	TRUE	90	11.00	47.60	TRUE
41	11.10	47.70	TRUE	91	11.00	47.60	TRUE
42	11.10	47.70	TRUE	92	11.00	47.60	TRUE
43	11.10	47.70	TRUE	93	11.00	47.60	TRUE
44	10.20	46.80	TRUE	94	11.00	47.60	TRUE
45	10.20	46.80	TRUE	95	11.00	47.60	TRUE
46	10.20	46.80	TRUE	96	11.00	47.60	TRUE
47	10.20	46.80	TRUE	97	11.00	47.60	TRUE
48	10.20	46.80	TRUE	98	11.30	47.90	TRUE
49	9.90	46.50	TRUE	99	11.30	47.90	TRUE
50	9.90	46.50	TRUE	100	11.30	47.90	TRUE

Table 53. (Continued)

Between population size = 10 and 20							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-13.10	23.50	FALSE	51	-8.30	28.30	FALSE
2	-10.40	26.20	FALSE	52	-8.50	28.10	FALSE
3	-11.40	25.20	FALSE	53	-8.50	28.10	FALSE
4	-13.30	23.30	FALSE	54	-8.90	27.70	FALSE
5	-7.60	29.00	FALSE	55	-9.10	27.50	FALSE
6	-6.10	30.50	FALSE	56	-9.10	27.50	FALSE
7	-5.80	30.80	FALSE	57	-9.10	27.50	FALSE
8	-7.10	29.50	FALSE	58	-9.10	27.50	FALSE
9	-7.20	29.40	FALSE	59	-9.10	27.50	FALSE
10	-4.00	32.60	FALSE	60	-9.10	27.50	FALSE
11	-3.40	33.20	FALSE	61	-9.10	27.50	FALSE
12	-3.90	32.70	FALSE	62	-8.30	28.30	FALSE
13	-4.30	32.30	FALSE	63	-8.30	28.30	FALSE
14	-4.50	32.10	FALSE	64	-7.60	29.00	FALSE
15	-4.50	32.10	FALSE	65	-7.80	28.80	FALSE
16	-6.70	29.90	FALSE	66	-7.80	28.80	FALSE
17	-6.70	29.90	FALSE	67	-7.80	28.80	FALSE
18	-6.70	29.90	FALSE	68	-7.80	28.80	FALSE
19	-6.70	29.90	FALSE	69	-7.80	28.80	FALSE
20	-6.70	29.90	FALSE	70	-7.80	28.80	FALSE
21	-6.70	29.90	FALSE	71	-7.80	28.80	FALSE
22	-8.30	28.30	FALSE	72	-7.70	28.90	FALSE
23	-8.60	28.00	FALSE	73	-7.70	28.90	FALSE
24	-8.60	28.00	FALSE	74	-7.70	28.90	FALSE
25	-8.60	28.00	FALSE	75	-7.70	28.90	FALSE
26	-8.60	28.00	FALSE	76	-7.70	28.90	FALSE
27	-6.00	30.60	FALSE	77	-7.70	28.90	FALSE
28	-6.00	30.60	FALSE	78	-7.70	28.90	FALSE
29	-6.10	30.50	FALSE	79	-7.70	28.90	FALSE
30	-6.10	30.50	FALSE	80	-7.70	28.90	FALSE
31	-6.10	30.50	FALSE	81	-7.70	28.90	FALSE
32	-8.30	28.30	FALSE	82	-7.70	28.90	FALSE
33	-8.30	28.30	FALSE	83	-7.70	28.90	FALSE
34	-8.30	28.30	FALSE	84	-7.90	28.70	FALSE
35	-8.30	28.30	FALSE	85	-7.60	29.00	FALSE
36	-8.30	28.30	FALSE	86	-7.60	29.00	FALSE
37	-8.30	28.30	FALSE	87	-7.30	29.30	FALSE
38	-8.30	28.30	FALSE	88	-7.30	29.30	FALSE
39	-8.30	28.30	FALSE	89	-7.30	29.30	FALSE
40	-8.60	28.00	FALSE	90	-7.10	29.50	FALSE
41	-8.60	28.00	FALSE	91	-7.10	29.50	FALSE
42	-8.60	28.00	FALSE	92	-7.10	29.50	FALSE
43	-8.60	28.00	FALSE	93	-7.10	29.50	FALSE
44	-8.20	28.40	FALSE	94	-7.10	29.50	FALSE
45	-8.20	28.40	FALSE	95	-7.10	29.50	FALSE
46	-8.20	28.40	FALSE	96	-7.10	29.50	FALSE
47	-8.20	28.40	FALSE	97	-7.10	29.50	FALSE
48	-8.20	28.40	FALSE	98	-8.00	28.60	FALSE
49	-8.10	28.50	FALSE	99	-8.00	28.60	FALSE
50	-8.10	28.50	FALSE	100	-8.00	28.60	FALSE

Table 53. (Continued)

Between population size = 10 and 50							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-5.20	31.40	FALSE	51	-1.00	35.60	FALSE
2	-4.60	32.00	FALSE	52	-1.10	35.50	FALSE
3	-0.30	36.30	FALSE	53	-1.10	35.50	FALSE
4	-0.40	36.20	FALSE	54	0.40	37.00	TRUE
5	-0.80	35.80	FALSE	55	1.10	37.70	TRUE
6	-1.50	35.10	FALSE	56	1.10	37.70	TRUE
7	-1.10	35.50	FALSE	57	1.10	37.70	TRUE
8	-1.00	35.60	FALSE	58	1.10	37.70	TRUE
9	-0.90	35.70	FALSE	59	1.10	37.70	TRUE
10	-1.20	35.40	FALSE	60	1.10	37.70	TRUE
11	-1.40	35.20	FALSE	61	1.10	37.70	TRUE
12	0.30	36.90	TRUE	62	1.00	37.60	TRUE
13	-0.20	36.40	FALSE	63	1.00	37.60	TRUE
14	-0.50	36.10	FALSE	64	1.30	37.90	TRUE
15	-0.50	36.10	FALSE	65	2.20	38.80	TRUE
16	-2.80	33.80	FALSE	66	2.20	38.80	TRUE
17	-2.80	33.80	FALSE	67	2.20	38.80	TRUE
18	-2.80	33.80	FALSE	68	2.20	38.80	TRUE
19	-2.80	33.80	FALSE	69	2.20	38.80	TRUE
20	-2.80	33.80	FALSE	70	2.20	38.80	TRUE
21	-2.80	33.80	FALSE	71	2.20	38.80	TRUE
22	-4.30	32.30	FALSE	72	2.30	38.90	TRUE
23	-4.70	31.90	FALSE	73	2.30	38.90	TRUE
24	-4.70	31.90	FALSE	74	2.30	38.90	TRUE
25	-4.70	31.90	FALSE	75	2.30	38.90	TRUE
26	-4.70	31.90	FALSE	76	2.30	38.90	TRUE
27	-4.40	32.20	FALSE	77	2.30	38.90	TRUE
28	-4.40	32.20	FALSE	78	2.30	38.90	TRUE
29	-4.50	32.10	FALSE	79	2.30	38.90	TRUE
30	-4.50	32.10	FALSE	80	2.30	38.90	TRUE
31	-4.50	32.10	FALSE	81	2.30	38.90	TRUE
32	-6.90	29.70	FALSE	82	2.30	38.90	TRUE
33	-6.90	29.70	FALSE	83	2.30	38.90	TRUE
34	-6.90	29.70	FALSE	84	2.00	38.60	TRUE
35	-6.90	29.70	FALSE	85	1.60	38.20	TRUE
36	-5.40	31.20	FALSE	86	1.60	38.20	TRUE
37	-5.40	31.20	FALSE	87	1.60	38.20	TRUE
38	-5.40	31.20	FALSE	88	1.60	38.20	TRUE
39	-5.40	31.20	FALSE	89	1.60	38.20	TRUE
40	-2.40	34.20	FALSE	90	2.00	38.60	TRUE
41	-2.40	34.20	FALSE	91	2.00	38.60	TRUE
42	-2.40	34.20	FALSE	92	2.00	38.60	TRUE
43	-2.40	34.20	FALSE	93	2.00	38.60	TRUE
44	-1.90	34.70	FALSE	94	2.00	38.60	TRUE
45	-1.90	34.70	FALSE	95	2.00	38.60	TRUE
46	-1.90	34.70	FALSE	96	2.00	38.60	TRUE
47	-1.90	34.70	FALSE	97	2.00	38.60	TRUE
48	-1.90	34.70	FALSE	98	1.40	38.00	TRUE
49	-1.70	34.90	FALSE	99	1.40	38.00	TRUE
50	-1.70	34.90	FALSE	100	1.40	38.00	TRUE

Table 53. (Continued)

Between population size = 10 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	1.30	37.90	TRUE	51	6.30	42.90	TRUE
2	2.10	38.70	TRUE	52	6.20	42.80	TRUE
3	0.80	37.40	TRUE	53	6.20	42.80	TRUE
4	-0.40	36.20	FALSE	54	6.20	42.80	TRUE
5	-1.20	35.40	FALSE	55	6.10	42.70	TRUE
6	4.70	41.30	TRUE	56	6.10	42.70	TRUE
7	7.00	43.60	TRUE	57	6.10	42.70	TRUE
8	6.00	42.60	TRUE	58	6.10	42.70	TRUE
9	5.90	42.50	TRUE	59	6.10	42.70	TRUE
10	5.80	42.40	TRUE	60	6.10	42.70	TRUE
11	5.40	42.00	TRUE	61	6.10	42.70	TRUE
12	4.90	41.50	TRUE	62	5.10	41.70	TRUE
13	5.90	42.50	TRUE	63	5.10	41.70	TRUE
14	6.40	43.00	TRUE	64	5.40	42.00	TRUE
15	6.40	43.00	TRUE	65	5.20	41.80	TRUE
16	6.30	42.90	TRUE	66	5.20	41.80	TRUE
17	6.30	42.90	TRUE	67	5.20	41.80	TRUE
18	6.30	42.90	TRUE	68	5.20	41.80	TRUE
19	6.30	42.90	TRUE	69	5.20	41.80	TRUE
20	6.30	42.90	TRUE	70	5.20	41.80	TRUE
21	6.30	42.90	TRUE	71	5.20	41.80	TRUE
22	4.80	41.40	TRUE	72	5.30	41.90	TRUE
23	6.00	42.60	TRUE	73	5.30	41.90	TRUE
24	6.00	42.60	TRUE	74	5.30	41.90	TRUE
25	6.00	42.60	TRUE	75	5.30	41.90	TRUE
26	6.00	42.60	TRUE	76	5.30	41.90	TRUE
27	6.60	43.20	TRUE	77	5.30	41.90	TRUE
28	6.60	43.20	TRUE	78	5.30	41.90	TRUE
29	7.40	44.00	TRUE	79	5.30	41.90	TRUE
30	7.40	44.00	TRUE	80	5.30	41.90	TRUE
31	7.40	44.00	TRUE	81	5.30	41.90	TRUE
32	5.10	41.70	TRUE	82	5.30	41.90	TRUE
33	5.10	41.70	TRUE	83	5.30	41.90	TRUE
34	5.10	41.70	TRUE	84	6.20	42.80	TRUE
35	5.10	41.70	TRUE	85	8.50	45.10	TRUE
36	5.50	42.10	TRUE	86	8.50	45.10	TRUE
37	5.50	42.10	TRUE	87	8.60	45.20	TRUE
38	5.50	42.10	TRUE	88	8.60	45.20	TRUE
39	5.50	42.10	TRUE	89	8.60	45.20	TRUE
40	5.60	42.20	TRUE	90	9.10	45.70	TRUE
41	5.60	42.20	TRUE	91	9.10	45.70	TRUE
42	5.60	42.20	TRUE	92	9.10	45.70	TRUE
43	5.60	42.20	TRUE	93	9.10	45.70	TRUE
44	6.20	42.80	TRUE	94	9.10	45.70	TRUE
45	6.20	42.80	TRUE	95	9.10	45.70	TRUE
46	6.20	42.80	TRUE	96	9.10	45.70	TRUE
47	6.20	42.80	TRUE	97	9.10	45.70	TRUE
48	6.20	42.80	TRUE	98	8.50	45.10	TRUE
49	6.40	43.00	TRUE	99	8.50	45.10	TRUE
50	6.40	43.00	TRUE	100	8.50	45.10	TRUE

Table 53. (Continued)

Between population size = 20 and 50							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-10.40	26.20	FALSE	51	-11.00	25.60	FALSE
2	-12.50	24.10	FALSE	52	-10.90	25.70	FALSE
3	-7.20	29.40	FALSE	53	-10.90	25.70	FALSE
4	-5.40	31.20	FALSE	54	-9.00	27.60	FALSE
5	-11.50	25.10	FALSE	55	-8.10	28.50	FALSE
6	-13.70	22.90	FALSE	56	-8.10	28.50	FALSE
7	-13.60	23.00	FALSE	57	-8.10	28.50	FALSE
8	-12.20	24.40	FALSE	58	-8.10	28.50	FALSE
9	-12.00	24.60	FALSE	59	-8.10	28.50	FALSE
10	-15.50	21.10	FALSE	60	-8.10	28.50	FALSE
11	-16.30	20.30	FALSE	61	-8.10	28.50	FALSE
12	-14.10	22.50	FALSE	62	-9.00	27.60	FALSE
13	-14.20	22.40	FALSE	63	-9.00	27.60	FALSE
14	-14.30	22.30	FALSE	64	-9.40	27.20	FALSE
15	-14.30	22.30	FALSE	65	-8.30	28.30	FALSE
16	-14.40	22.20	FALSE	66	-8.30	28.30	FALSE
17	-14.40	22.20	FALSE	67	-8.30	28.30	FALSE
18	-14.40	22.20	FALSE	68	-8.30	28.30	FALSE
19	-14.40	22.20	FALSE	69	-8.30	28.30	FALSE
20	-14.40	22.20	FALSE	70	-8.30	28.30	FALSE
21	-14.40	22.20	FALSE	71	-8.30	28.30	FALSE
22	-14.30	22.30	FALSE	72	-8.30	28.30	FALSE
23	-14.40	22.20	FALSE	73	-8.30	28.30	FALSE
24	-14.40	22.20	FALSE	74	-8.30	28.30	FALSE
25	-14.40	22.20	FALSE	75	-8.30	28.30	FALSE
26	-14.40	22.20	FALSE	76	-8.30	28.30	FALSE
27	-16.70	19.90	FALSE	77	-8.30	28.30	FALSE
28	-16.70	19.90	FALSE	78	-8.30	28.30	FALSE
29	-16.70	19.90	FALSE	79	-8.30	28.30	FALSE
30	-16.70	19.90	FALSE	80	-8.30	28.30	FALSE
31	-16.70	19.90	FALSE	81	-8.30	28.30	FALSE
32	-16.90	19.70	FALSE	82	-8.30	28.30	FALSE
33	-16.90	19.70	FALSE	83	-8.30	28.30	FALSE
34	-16.90	19.70	FALSE	84	-8.40	28.20	FALSE
35	-16.90	19.70	FALSE	85	-9.10	27.50	FALSE
36	-15.40	21.20	FALSE	86	-9.10	27.50	FALSE
37	-15.40	21.20	FALSE	87	-9.40	27.20	FALSE
38	-15.40	21.20	FALSE	88	-9.40	27.20	FALSE
39	-15.40	21.20	FALSE	89	-9.40	27.20	FALSE
40	-12.10	24.50	FALSE	90	-9.20	27.40	FALSE
41	-12.10	24.50	FALSE	91	-9.20	27.40	FALSE
42	-12.10	24.50	FALSE	92	-9.20	27.40	FALSE
43	-12.10	24.50	FALSE	93	-9.20	27.40	FALSE
44	-12.00	24.60	FALSE	94	-9.20	27.40	FALSE
45	-12.00	24.60	FALSE	95	-9.20	27.40	FALSE
46	-12.00	24.60	FALSE	96	-9.20	27.40	FALSE
47	-12.00	24.60	FALSE	97	-9.20	27.40	FALSE
48	-12.00	24.60	FALSE	98	-8.90	27.70	FALSE
49	-11.90	24.70	FALSE	99	-8.90	27.70	FALSE
50	-11.90	24.70	FALSE	100	-8.90	27.70	FALSE

Table 53. (Continued)

Between population size = 20 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-3.90	32.70	FALSE	51	-3.70	32.90	FALSE
2	-5.80	30.80	FALSE	52	-3.60	33.00	FALSE
3	-6.10	30.50	FALSE	53	-3.60	33.00	FALSE
4	-5.40	31.20	FALSE	54	-3.20	33.40	FALSE
5	-11.90	24.70	FALSE	55	-3.10	33.50	FALSE
6	-7.50	29.10	FALSE	56	-3.10	33.50	FALSE
7	-5.50	31.10	FALSE	57	-3.10	33.50	FALSE
8	-5.20	31.40	FALSE	58	-3.10	33.50	FALSE
9	-5.20	31.40	FALSE	59	-3.10	33.50	FALSE
10	-8.50	28.10	FALSE	60	-3.10	33.50	FALSE
11	-9.50	27.10	FALSE	61	-3.10	33.50	FALSE
12	-9.50	27.10	FALSE	62	-4.90	31.70	FALSE
13	-8.10	28.50	FALSE	63	-4.90	31.70	FALSE
14	-7.40	29.20	FALSE	64	-5.30	31.30	FALSE
15	-7.40	29.20	FALSE	65	-5.30	31.30	FALSE
16	-5.30	31.30	FALSE	66	-5.30	31.30	FALSE
17	-5.30	31.30	FALSE	67	-5.30	31.30	FALSE
18	-5.30	31.30	FALSE	68	-5.30	31.30	FALSE
19	-5.30	31.30	FALSE	69	-5.30	31.30	FALSE
20	-5.30	31.30	FALSE	70	-5.30	31.30	FALSE
21	-5.30	31.30	FALSE	71	-5.30	31.30	FALSE
22	-5.20	31.40	FALSE	72	-5.30	31.30	FALSE
23	-3.70	32.90	FALSE	73	-5.30	31.30	FALSE
24	-3.70	32.90	FALSE	74	-5.30	31.30	FALSE
25	-3.70	32.90	FALSE	75	-5.30	31.30	FALSE
26	-3.70	32.90	FALSE	76	-5.30	31.30	FALSE
27	-5.70	30.90	FALSE	77	-5.30	31.30	FALSE
28	-5.70	30.90	FALSE	78	-5.30	31.30	FALSE
29	-4.80	31.80	FALSE	79	-5.30	31.30	FALSE
30	-4.80	31.80	FALSE	80	-5.30	31.30	FALSE
31	-4.80	31.80	FALSE	81	-5.30	31.30	FALSE
32	-4.90	31.70	FALSE	82	-5.30	31.30	FALSE
33	-4.90	31.70	FALSE	83	-5.30	31.30	FALSE
34	-4.90	31.70	FALSE	84	-4.20	32.40	FALSE
35	-4.90	31.70	FALSE	85	-2.20	34.40	FALSE
36	-4.50	32.10	FALSE	86	-2.20	34.40	FALSE
37	-4.50	32.10	FALSE	87	-2.40	34.20	FALSE
38	-4.50	32.10	FALSE	88	-2.40	34.20	FALSE
39	-4.50	32.10	FALSE	89	-2.40	34.20	FALSE
40	-4.10	32.50	FALSE	90	-2.10	34.50	FALSE
41	-4.10	32.50	FALSE	91	-2.10	34.50	FALSE
42	-4.10	32.50	FALSE	92	-2.10	34.50	FALSE
43	-4.10	32.50	FALSE	93	-2.10	34.50	FALSE
44	-3.90	32.70	FALSE	94	-2.10	34.50	FALSE
45	-3.90	32.70	FALSE	95	-2.10	34.50	FALSE
46	-3.90	32.70	FALSE	96	-2.10	34.50	FALSE
47	-3.90	32.70	FALSE	97	-2.10	34.50	FALSE
48	-3.90	32.70	FALSE	98	-1.80	34.80	FALSE
49	-3.80	32.80	FALSE	99	-1.80	34.80	FALSE
50	-3.80	32.80	FALSE	100	-1.80	34.80	FALSE

Table 53. (Continued)

Between population size = 50 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-11.80	24.80	FALSE	51	-11.00	25.60	FALSE
2	-11.60	25.00	FALSE	52	-11.00	25.60	FALSE
3	-17.20	19.40	FALSE	53	-11.00	25.60	FALSE
4	-18.30	18.30	FALSE	54	-12.50	24.10	FALSE
5	-18.70	17.90	FALSE	55	-13.30	23.30	FALSE
6	-12.10	24.50	FALSE	56	-13.30	23.30	FALSE
7	-10.20	26.40	FALSE	57	-13.30	23.30	FALSE
8	-11.30	25.30	FALSE	58	-13.30	23.30	FALSE
9	-11.50	25.10	FALSE	59	-13.30	23.30	FALSE
10	-11.30	25.30	FALSE	60	-13.30	23.30	FALSE
11	-11.50	25.10	FALSE	61	-13.30	23.30	FALSE
12	-13.70	22.90	FALSE	62	-14.20	22.40	FALSE
13	-12.20	24.40	FALSE	63	-14.20	22.40	FALSE
14	-11.40	25.20	FALSE	64	-14.20	22.40	FALSE
15	-11.40	25.20	FALSE	65	-15.30	21.30	FALSE
16	-9.20	27.40	FALSE	66	-15.30	21.30	FALSE
17	-9.20	27.40	FALSE	67	-15.30	21.30	FALSE
18	-9.20	27.40	FALSE	68	-15.30	21.30	FALSE
19	-9.20	27.40	FALSE	69	-15.30	21.30	FALSE
20	-9.20	27.40	FALSE	70	-15.30	21.30	FALSE
21	-9.20	27.40	FALSE	71	-15.30	21.30	FALSE
22	-9.20	27.40	FALSE	72	-15.30	21.30	FALSE
23	-7.60	29.00	FALSE	73	-15.30	21.30	FALSE
24	-7.60	29.00	FALSE	74	-15.30	21.30	FALSE
25	-7.60	29.00	FALSE	75	-15.30	21.30	FALSE
26	-7.60	29.00	FALSE	76	-15.30	21.30	FALSE
27	-7.30	29.30	FALSE	77	-15.30	21.30	FALSE
28	-7.30	29.30	FALSE	78	-15.30	21.30	FALSE
29	-6.40	30.20	FALSE	79	-15.30	21.30	FALSE
30	-6.40	30.20	FALSE	80	-15.30	21.30	FALSE
31	-6.40	30.20	FALSE	81	-15.30	21.30	FALSE
32	-6.30	30.30	FALSE	82	-15.30	21.30	FALSE
33	-6.30	30.30	FALSE	83	-15.30	21.30	FALSE
34	-6.30	30.30	FALSE	84	-14.10	22.50	FALSE
35	-6.30	30.30	FALSE	85	-11.40	25.20	FALSE
36	-7.40	29.20	FALSE	86	-11.40	25.20	FALSE
37	-7.40	29.20	FALSE	87	-11.30	25.30	FALSE
38	-7.40	29.20	FALSE	88	-11.30	25.30	FALSE
39	-7.40	29.20	FALSE	89	-11.30	25.30	FALSE
40	-10.30	26.30	FALSE	90	-11.20	25.40	FALSE
41	-10.30	26.30	FALSE	91	-11.20	25.40	FALSE
42	-10.30	26.30	FALSE	92	-11.20	25.40	FALSE
43	-10.30	26.30	FALSE	93	-11.20	25.40	FALSE
44	-10.20	26.40	FALSE	94	-11.20	25.40	FALSE
45	-10.20	26.40	FALSE	95	-11.20	25.40	FALSE
46	-10.20	26.40	FALSE	96	-11.20	25.40	FALSE
47	-10.20	26.40	FALSE	97	-11.20	25.40	FALSE
48	-10.20	26.40	FALSE	98	-11.20	25.40	FALSE
49	-10.20	26.40	FALSE	99	-11.20	25.40	FALSE
50	-10.20	26.40	FALSE	100	-11.20	25.40	FALSE

Table 54. Results of multiple pair wise comparisons for six decision variable case

Between population size = 5 and 10							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-10.60	26.00	FALSE	51	-7.40	29.20	FALSE
2	-9.70	26.90	FALSE	52	-6.80	29.80	FALSE
3	-5.10	31.50	FALSE	53	-6.80	29.80	FALSE
4	-7.00	29.60	FALSE	54	-6.50	30.10	FALSE
5	-9.30	27.30	FALSE	55	-6.50	30.10	FALSE
6	-11.20	25.40	FALSE	56	-6.50	30.10	FALSE
7	-12.00	24.60	FALSE	57	-6.50	30.10	FALSE
8	-11.20	25.40	FALSE	58	-6.60	30.00	FALSE
9	-10.90	25.70	FALSE	59	-6.20	30.40	FALSE
10	-10.60	26.00	FALSE	60	-6.90	29.70	FALSE
11	-10.40	26.20	FALSE	61	-7.30	29.30	FALSE
12	-10.60	26.00	FALSE	62	-7.30	29.30	FALSE
13	-9.40	27.20	FALSE	63	-7.90	28.70	FALSE
14	-10.50	26.10	FALSE	64	-7.60	29.00	FALSE
15	-8.50	28.10	FALSE	65	-8.20	28.40	FALSE
16	-8.40	28.20	FALSE	66	-7.30	29.30	FALSE
17	-8.30	28.30	FALSE	67	-8.70	27.90	FALSE
18	-7.50	29.10	FALSE	68	-8.80	27.80	FALSE
19	-7.80	28.80	FALSE	69	-10.60	26.00	FALSE
20	-8.10	28.50	FALSE	70	-10.10	26.50	FALSE
21	-8.40	28.20	FALSE	71	-10.30	26.30	FALSE
22	-9.20	27.40	FALSE	72	-10.70	25.90	FALSE
23	-9.30	27.30	FALSE	73	-10.70	25.90	FALSE
24	-9.80	26.80	FALSE	74	-10.70	25.90	FALSE
25	-9.70	26.90	FALSE	75	-12.70	23.90	FALSE
26	-10.20	26.40	FALSE	76	-12.80	23.80	FALSE
27	-10.50	26.10	FALSE	77	-12.80	23.80	FALSE
28	-10.50	26.10	FALSE	78	-12.50	24.10	FALSE
29	-10.10	26.50	FALSE	79	-12.50	24.10	FALSE
30	-10.10	26.50	FALSE	80	-12.40	24.20	FALSE
31	-10.30	26.30	FALSE	81	-12.50	24.10	FALSE
32	-10.30	26.30	FALSE	82	-12.60	24.00	FALSE
33	-8.90	27.70	FALSE	83	-13.00	23.60	FALSE
34	-7.90	28.70	FALSE	84	-13.00	23.60	FALSE
35	-7.90	28.70	FALSE	85	-13.60	23.00	FALSE
36	-8.00	28.60	FALSE	86	-13.70	22.90	FALSE
37	-7.80	28.80	FALSE	87	-13.60	23.00	FALSE
38	-7.70	28.90	FALSE	88	-12.20	24.40	FALSE
39	-7.70	28.90	FALSE	89	-12.20	24.40	FALSE
40	-7.60	29.00	FALSE	90	-12.20	24.40	FALSE
41	-7.80	28.80	FALSE	91	-12.50	24.10	FALSE
42	-8.60	28.00	FALSE	92	-12.50	24.10	FALSE
43	-8.90	27.70	FALSE	93	-12.70	23.90	FALSE
44	-9.00	27.60	FALSE	94	-12.40	24.20	FALSE
45	-9.20	27.40	FALSE	95	-12.40	24.20	FALSE
46	-6.90	29.70	FALSE	96	-12.10	24.50	FALSE
47	-7.20	29.40	FALSE	97	-12.20	24.40	FALSE
48	-7.50	29.10	FALSE	98	-12.20	24.40	FALSE
49	-6.80	29.80	FALSE	99	-11.90	24.70	FALSE
50	-7.40	29.20	FALSE	100	-12.40	24.20	FALSE

Table 54. (Continued)

Between population size = 5 and 20							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	0.20	36.80	TRUE	51	0.20	29.60	TRUE
2	0.20	39.00	TRUE	52	0.20	29.70	TRUE
3	0.20	38.30	TRUE	53	0.20	29.70	TRUE
4	0.20	35.80	TRUE	54	-7.10	29.50	FALSE
5	0.20	34.80	TRUE	55	-7.10	29.50	FALSE
6	0.20	34.40	TRUE	56	-7.40	29.20	FALSE
7	0.20	32.20	TRUE	57	-7.40	29.20	FALSE
8	0.20	30.70	TRUE	58	-7.20	29.40	FALSE
9	0.20	31.10	TRUE	59	-6.70	29.90	FALSE
10	0.20	31.30	TRUE	60	-7.60	29.00	FALSE
11	0.20	30.40	TRUE	61	-7.80	28.80	FALSE
12	0.20	31.10	TRUE	62	-7.80	28.80	FALSE
13	0.20	31.00	TRUE	63	-7.50	29.10	FALSE
14	0.20	30.50	TRUE	64	-7.90	28.70	FALSE
15	0.20	30.10	TRUE	65	-5.40	31.20	FALSE
16	0.20	29.00	TRUE	66	-5.80	30.80	FALSE
17	0.20	29.90	TRUE	67	-7.60	29.00	FALSE
18	0.20	30.00	TRUE	68	-7.40	29.20	FALSE
19	0.20	29.50	TRUE	69	-10.10	26.50	FALSE
20	0.20	29.60	TRUE	70	-10.30	26.30	FALSE
21	0.20	29.90	TRUE	71	-10.30	26.30	FALSE
22	0.20	28.80	TRUE	72	-10.20	26.40	FALSE
23	0.20	28.60	TRUE	73	-10.20	26.40	FALSE
24	0.20	28.00	TRUE	74	-9.60	27.00	FALSE
25	0.20	28.00	TRUE	75	-11.50	25.10	FALSE
26	0.20	27.40	TRUE	76	-11.70	24.90	FALSE
27	0.20	27.30	TRUE	77	-11.70	24.90	FALSE
28	0.20	27.30	TRUE	78	-11.80	24.80	FALSE
29	0.20	27.50	TRUE	79	-11.80	24.80	FALSE
30	0.20	27.60	TRUE	80	-11.70	24.90	FALSE
31	0.20	28.20	TRUE	81	-11.50	25.10	FALSE
32	0.20	28.50	TRUE	82	-11.70	24.90	FALSE
33	0.20	28.20	TRUE	83	-10.90	25.70	FALSE
34	0.20	27.80	TRUE	84	-10.90	25.70	FALSE
35	0.20	27.80	TRUE	85	-11.70	24.90	FALSE
36	0.20	27.30	TRUE	86	-11.80	24.80	FALSE
37	0.20	27.40	TRUE	87	-11.10	25.50	FALSE
38	0.20	27.60	TRUE	88	-11.10	25.50	FALSE
39	0.20	27.60	TRUE	89	-11.10	25.50	FALSE
40	0.20	27.10	TRUE	90	-11.10	25.50	FALSE
41	0.20	27.10	TRUE	91	-10.20	26.40	FALSE
42	0.20	27.80	TRUE	92	-10.50	26.10	FALSE
43	0.20	27.60	TRUE	93	-10.30	26.30	FALSE
44	0.20	27.60	TRUE	94	-10.10	26.50	FALSE
45	0.20	27.60	TRUE	95	-9.80	26.80	FALSE
46	0.20	28.50	TRUE	96	-10.00	26.60	FALSE
47	0.20	28.50	TRUE	97	-10.30	26.30	FALSE
48	0.20	28.30	TRUE	98	-10.30	26.30	FALSE
49	0.20	28.20	TRUE	99	-10.80	25.80	FALSE
50	0.20	29.60	TRUE	100	-11.00	25.60	FALSE

Table 54. (Continued)

Between population size = 5 and 50							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	5.80	42.40	TRUE	51	5.60	42.20	TRUE
2	5.20	41.80	TRUE	52	5.90	42.50	TRUE
3	-0.10	36.50	FALSE	53	5.90	42.50	TRUE
4	0.30	36.90	TRUE	54	5.80	42.40	TRUE
5	2.90	39.50	TRUE	55	5.80	42.40	TRUE
6	-0.50	36.10	FALSE	56	5.70	42.30	TRUE
7	2.10	38.70	TRUE	57	5.80	42.40	TRUE
8	1.90	38.50	TRUE	58	5.60	42.20	TRUE
9	2.40	39.00	TRUE	59	6.10	42.70	TRUE
10	1.20	37.80	TRUE	60	5.70	42.30	TRUE
11	1.30	37.90	TRUE	61	6.20	42.80	TRUE
12	1.30	37.90	TRUE	62	6.20	42.80	TRUE
13	1.00	37.60	TRUE	63	5.80	42.40	TRUE
14	2.30	38.90	TRUE	64	6.50	43.10	TRUE
15	2.10	38.70	TRUE	65	5.60	42.20	TRUE
16	1.90	38.50	TRUE	66	5.50	42.10	TRUE
17	2.50	39.10	TRUE	67	4.30	40.90	TRUE
18	2.90	39.50	TRUE	68	4.20	40.80	TRUE
19	1.40	38.00	TRUE	69	1.80	38.40	TRUE
20	1.20	37.80	TRUE	70	1.60	38.20	TRUE
21	0.80	37.40	TRUE	71	2.20	38.80	TRUE
22	-0.10	36.50	FALSE	72	1.70	38.30	TRUE
23	-0.20	36.40	FALSE	73	2.30	38.90	TRUE
24	-0.70	35.90	FALSE	74	2.50	39.10	TRUE
25	-0.40	36.20	FALSE	75	0.20	36.80	TRUE
26	-0.90	35.70	FALSE	76	0.50	37.10	TRUE
27	-0.50	36.10	FALSE	77	0.40	37.00	TRUE
28	-0.50	36.10	FALSE	78	1.00	37.60	TRUE
29	-0.30	36.30	FALSE	79	1.00	37.60	TRUE
30	-0.40	36.20	FALSE	80	1.00	37.60	TRUE
31	-0.80	35.80	FALSE	81	0.50	37.10	TRUE
32	0.00	36.60	TRUE	82	0.80	37.40	TRUE
33	0.00	36.60	TRUE	83	0.80	37.40	TRUE
34	-0.60	36.00	FALSE	84	0.80	37.40	TRUE
35	-0.60	36.00	FALSE	85	0.40	37.00	TRUE
36	0.40	37.00	TRUE	86	0.60	37.20	TRUE
37	0.90	37.50	TRUE	87	0.30	36.90	TRUE
38	1.00	37.60	TRUE	88	0.20	36.80	TRUE
39	1.00	37.60	TRUE	89	0.20	36.80	TRUE
40	1.20	37.80	TRUE	90	0.20	36.80	TRUE
41	1.50	38.10	TRUE	91	0.00	36.60	TRUE
42	0.80	37.40	TRUE	92	0.30	36.90	TRUE
43	1.30	37.90	TRUE	93	0.20	36.80	TRUE
44	1.80	38.40	TRUE	94	0.90	37.50	TRUE
45	3.00	39.60	TRUE	95	1.10	37.70	TRUE
46	4.30	40.90	TRUE	96	1.00	37.60	TRUE
47	5.10	41.70	TRUE	97	1.40	38.00	TRUE
48	5.80	42.40	TRUE	98	1.40	38.00	TRUE
49	5.60	42.20	TRUE	99	1.40	38.00	TRUE
50	5.60	42.20	TRUE	100	1.70	38.30	TRUE

Table 54. (Continued)

Between population size = 5 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	12.40	49.00	TRUE	51	12.40	53.20	TRUE
2	12.40	52.50	TRUE	52	12.40	53.20	TRUE
3	12.40	50.90	TRUE	53	12.40	53.20	TRUE
4	12.40	50.90	TRUE	54	12.40	53.20	TRUE
5	12.40	50.60	TRUE	55	12.40	53.20	TRUE
6	12.40	49.30	TRUE	56	12.40	53.10	TRUE
7	12.40	49.20	TRUE	57	16.90	53.50	TRUE
8	12.40	48.10	TRUE	58	17.50	54.10	TRUE
9	12.40	47.90	TRUE	59	17.60	54.20	TRUE
10	12.40	48.60	TRUE	60	17.10	53.70	TRUE
11	12.40	49.20	TRUE	61	17.20	53.80	TRUE
12	12.40	50.20	TRUE	62	17.20	53.80	TRUE
13	12.40	49.90	TRUE	63	16.90	53.50	TRUE
14	12.40	50.20	TRUE	64	16.80	53.40	TRUE
15	12.40	52.80	TRUE	65	16.80	53.40	TRUE
16	12.40	52.50	TRUE	66	16.90	53.50	TRUE
17	12.40	52.90	TRUE	67	15.80	52.40	TRUE
18	12.40	52.10	TRUE	68	15.80	52.40	TRUE
19	12.40	52.90	TRUE	69	13.70	50.30	TRUE
20	12.40	53.30	TRUE	70	13.60	50.20	TRUE
21	12.40	53.20	TRUE	71	13.70	50.30	TRUE
22	12.40	52.50	TRUE	72	13.50	50.10	TRUE
23	12.40	52.40	TRUE	73	13.40	50.00	TRUE
24	12.40	52.00	TRUE	74	13.60	50.20	TRUE
25	12.40	52.10	TRUE	75	11.30	47.90	TRUE
26	12.40	51.70	TRUE	76	11.30	47.90	TRUE
27	12.40	51.70	TRUE	77	11.40	48.00	TRUE
28	12.40	51.70	TRUE	78	11.10	47.70	TRUE
29	12.40	51.90	TRUE	79	11.10	47.70	TRUE
30	12.40	51.90	TRUE	80	11.40	48.00	TRUE
31	12.40	51.90	TRUE	81	12.30	48.90	TRUE
32	12.40	52.30	TRUE	82	12.30	48.90	TRUE
33	12.40	52.70	TRUE	83	12.40	49.00	TRUE
34	12.40	52.70	TRUE	84	12.40	49.00	TRUE
35	12.40	52.70	TRUE	85	12.20	48.80	TRUE
36	12.40	52.80	TRUE	86	12.20	48.80	TRUE
37	12.40	53.00	TRUE	87	12.20	48.80	TRUE
38	12.40	53.10	TRUE	88	11.40	48.00	TRUE
39	12.40	53.10	TRUE	89	11.40	48.00	TRUE
40	12.40	52.80	TRUE	90	11.40	48.00	TRUE
41	12.40	52.70	TRUE	91	11.50	48.10	TRUE
42	12.40	52.50	TRUE	92	11.50	48.10	TRUE
43	12.40	52.50	TRUE	93	11.60	48.20	TRUE
44	12.40	52.60	TRUE	94	11.90	48.50	TRUE
45	12.40	52.60	TRUE	95	11.90	48.50	TRUE
46	12.40	53.60	TRUE	96	11.90	48.50	TRUE
47	12.40	53.60	TRUE	97	11.90	48.50	TRUE
48	12.40	53.40	TRUE	98	11.90	48.50	TRUE
49	12.40	53.50	TRUE	99	11.60	48.20	TRUE
50	12.40	53.20	TRUE	100	11.50	48.10	TRUE

Table 54. (Continued)

Between population size = 10 and 20							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-7.50	29.10	FALSE	51	-17.90	18.70	FALSE
2	-6.20	30.40	FALSE	52	-18.40	18.20	FALSE
3	-11.50	25.10	FALSE	53	-18.40	18.20	FALSE
4	-12.10	24.50	FALSE	54	-18.90	17.70	FALSE
5	-10.80	25.80	FALSE	55	-18.90	17.70	FALSE
6	-9.30	27.30	FALSE	56	-19.20	17.40	FALSE
7	-10.70	25.90	FALSE	57	-19.20	17.40	FALSE
8	-13.00	23.60	FALSE	58	-18.90	17.70	FALSE
9	-12.90	23.70	FALSE	59	-18.80	17.80	FALSE
10	-13.00	23.60	FALSE	60	-19.00	17.60	FALSE
11	-14.10	22.50	FALSE	61	-18.80	17.80	FALSE
12	-13.20	23.40	FALSE	62	-18.80	17.80	FALSE
13	-14.50	22.10	FALSE	63	-17.90	18.70	FALSE
14	-13.90	22.70	FALSE	64	-18.60	18.00	FALSE
15	-16.30	20.30	FALSE	65	-15.50	21.10	FALSE
16	-17.50	19.10	FALSE	66	-16.80	19.80	FALSE
17	-16.70	19.90	FALSE	67	-17.20	19.40	FALSE
18	-17.40	19.20	FALSE	68	-16.90	19.70	FALSE
19	-17.60	19.00	FALSE	69	-17.80	18.80	FALSE
20	-17.20	19.40	FALSE	70	-18.50	18.10	FALSE
21	-16.60	20.00	FALSE	71	-18.30	18.30	FALSE
22	-16.90	19.70	FALSE	72	-17.80	18.80	FALSE
23	-17.00	19.60	FALSE	73	-17.80	18.80	FALSE
24	-17.10	19.50	FALSE	74	-17.20	19.40	FALSE
25	-17.20	19.40	FALSE	75	-17.10	19.50	FALSE
26	-17.30	19.30	FALSE	76	-17.20	19.40	FALSE
27	-17.10	19.50	FALSE	77	-17.20	19.40	FALSE
28	-17.10	19.50	FALSE	78	-17.60	19.00	FALSE
29	-17.30	19.30	FALSE	79	-17.60	19.00	FALSE
30	-17.20	19.40	FALSE	80	-17.60	19.00	FALSE
31	-16.40	20.20	FALSE	81	-17.30	19.30	FALSE
32	-16.10	20.50	FALSE	82	-17.40	19.20	FALSE
33	-17.80	18.80	FALSE	83	-16.20	20.40	FALSE
34	-19.20	17.40	FALSE	84	-16.20	20.40	FALSE
35	-19.20	17.40	FALSE	85	-16.40	20.20	FALSE
36	-19.60	17.00	FALSE	86	-16.40	20.20	FALSE
37	-19.70	16.90	FALSE	87	-15.80	20.80	FALSE
38	-19.60	17.00	FALSE	88	-17.20	19.40	FALSE
39	-19.60	17.00	FALSE	89	-17.20	19.40	FALSE
40	-20.20	16.40	FALSE	90	-17.20	19.40	FALSE
41	-20.00	16.60	FALSE	91	-16.00	20.60	FALSE
42	-18.50	18.10	FALSE	92	-16.30	20.30	FALSE
43	-18.40	18.20	FALSE	93	-15.90	20.70	FALSE
44	-18.30	18.30	FALSE	94	-16.00	20.60	FALSE
45	-18.10	18.50	FALSE	95	-15.70	20.90	FALSE
46	-19.50	17.10	FALSE	96	-16.20	20.40	FALSE
47	-19.20	17.40	FALSE	97	-16.40	20.20	FALSE
48	-19.10	17.50	FALSE	98	-16.40	20.20	FALSE
49	-19.90	16.70	FALSE	99	-17.20	19.40	FALSE
50	-17.90	18.70	FALSE	100	-16.90	19.70	FALSE

Table 54. (Continued)

Between population size = 10 and 50							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-1.90	34.70	FALSE	51	-5.30	31.30	FALSE
2	-3.40	33.20	FALSE	52	-5.60	31.00	FALSE
3	-13.30	23.30	FALSE	53	-5.60	31.00	FALSE
4	-11.00	25.60	FALSE	54	-6.00	30.60	FALSE
5	-6.10	30.50	FALSE	55	-6.00	30.60	FALSE
6	-7.60	29.00	FALSE	56	-6.10	30.50	FALSE
7	-4.20	32.40	FALSE	57	-6.00	30.60	FALSE
8	-5.20	31.40	FALSE	58	-6.10	30.50	FALSE
9	-5.00	31.60	FALSE	59	-6.00	30.60	FALSE
10	-6.50	30.10	FALSE	60	-5.70	30.90	FALSE
11	-6.60	30.00	FALSE	61	-4.80	31.80	FALSE
12	-6.40	30.20	FALSE	62	-4.80	31.80	FALSE
13	-7.90	28.70	FALSE	63	-4.60	32.00	FALSE
14	-5.50	31.10	FALSE	64	-4.20	32.40	FALSE
15	-7.70	28.90	FALSE	65	-4.50	32.10	FALSE
16	-8.00	28.60	FALSE	66	-5.50	31.10	FALSE
17	-7.50	29.10	FALSE	67	-5.30	31.30	FALSE
18	-7.90	28.70	FALSE	68	-5.30	31.30	FALSE
19	-9.10	27.50	FALSE	69	-5.90	30.70	FALSE
20	-9.00	27.60	FALSE	70	-6.60	30.00	FALSE
21	-9.10	27.50	FALSE	71	-5.80	30.80	FALSE
22	-9.20	27.40	FALSE	72	-5.90	30.70	FALSE
23	-9.20	27.40	FALSE	73	-5.30	31.30	FALSE
24	-9.20	27.40	FALSE	74	-5.10	31.50	FALSE
25	-9.00	27.60	FALSE	75	-5.40	31.20	FALSE
26	-9.00	27.60	FALSE	76	-5.00	31.60	FALSE
27	-8.30	28.30	FALSE	77	-5.10	31.50	FALSE
28	-8.30	28.30	FALSE	78	-4.80	31.80	FALSE
29	-8.50	28.10	FALSE	79	-4.80	31.80	FALSE
30	-8.60	28.00	FALSE	80	-4.90	31.70	FALSE
31	-8.80	27.80	FALSE	81	-5.30	31.30	FALSE
32	-8.00	28.60	FALSE	82	-4.90	31.70	FALSE
33	-9.40	27.20	FALSE	83	-4.50	32.10	FALSE
34	-11.00	25.60	FALSE	84	-4.50	32.10	FALSE
35	-11.00	25.60	FALSE	85	-4.30	32.30	FALSE
36	-9.90	26.70	FALSE	86	-4.00	32.60	FALSE
37	-9.60	27.00	FALSE	87	-4.40	32.20	FALSE
38	-9.60	27.00	FALSE	88	-5.90	30.70	FALSE
39	-9.60	27.00	FALSE	89	-5.90	30.70	FALSE
40	-9.50	27.10	FALSE	90	-5.90	30.70	FALSE
41	-9.00	27.60	FALSE	91	-5.80	30.80	FALSE
42	-8.90	27.70	FALSE	92	-5.50	31.10	FALSE
43	-8.10	28.50	FALSE	93	-5.40	31.20	FALSE
44	-7.50	29.10	FALSE	94	-5.00	31.60	FALSE
45	-6.10	30.50	FALSE	95	-4.80	31.80	FALSE
46	-7.10	29.50	FALSE	96	-5.20	31.40	FALSE
47	-6.00	30.60	FALSE	97	-4.70	31.90	FALSE
48	-5.00	31.60	FALSE	98	-4.70	31.90	FALSE
49	-5.90	30.70	FALSE	99	-5.00	31.60	FALSE
50	-5.30	31.30	FALSE	100	-4.20	32.40	FALSE

Table 54. (Continued)

Between population size = 10 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	4.70	41.30	TRUE	51	5.70	42.30	TRUE
2	7.30	43.90	TRUE	52	5.10	41.70	TRUE
3	1.10	37.70	TRUE	53	5.10	41.70	TRUE
4	3.00	39.60	TRUE	54	4.80	41.40	TRUE
5	5.00	41.60	TRUE	55	4.80	41.40	TRUE
6	5.60	42.20	TRUE	56	4.70	41.30	TRUE
7	6.30	42.90	TRUE	57	5.10	41.70	TRUE
8	4.40	41.00	TRUE	58	5.80	42.40	TRUE
9	3.90	40.50	TRUE	59	5.50	42.10	TRUE
10	4.30	40.90	TRUE	60	5.70	42.30	TRUE
11	4.70	41.30	TRUE	61	6.20	42.80	TRUE
12	5.90	42.50	TRUE	62	6.20	42.80	TRUE
13	4.40	41.00	TRUE	63	6.50	43.10	TRUE
14	5.80	42.40	TRUE	64	6.10	42.70	TRUE
15	6.40	43.00	TRUE	65	6.70	43.30	TRUE
16	6.00	42.60	TRUE	66	5.90	42.50	TRUE
17	6.30	42.90	TRUE	67	6.20	42.80	TRUE
18	4.70	41.30	TRUE	68	6.30	42.90	TRUE
19	5.80	42.40	TRUE	69	6.00	42.60	TRUE
20	6.50	43.10	TRUE	70	5.40	42.00	TRUE
21	6.70	43.30	TRUE	71	5.70	42.30	TRUE
22	6.80	43.40	TRUE	72	5.90	42.50	TRUE
23	6.80	43.40	TRUE	73	5.80	42.40	TRUE
24	6.90	43.50	TRUE	74	6.00	42.60	TRUE
25	6.90	43.50	TRUE	75	5.70	42.30	TRUE
26	7.00	43.60	TRUE	76	5.80	42.40	TRUE
27	7.30	43.90	TRUE	77	5.90	42.50	TRUE
28	7.30	43.90	TRUE	78	5.30	41.90	TRUE
29	7.10	43.70	TRUE	79	5.30	41.90	TRUE
30	7.10	43.70	TRUE	80	5.50	42.10	TRUE
31	7.30	43.90	TRUE	81	6.50	43.10	TRUE
32	7.70	44.30	TRUE	82	6.60	43.20	TRUE
33	6.70	43.30	TRUE	83	7.10	43.70	TRUE
34	5.70	42.30	TRUE	84	7.10	43.70	TRUE
35	5.70	42.30	TRUE	85	7.50	44.10	TRUE
36	5.90	42.50	TRUE	86	7.60	44.20	TRUE
37	5.90	42.50	TRUE	87	7.50	44.10	TRUE
38	5.90	42.50	TRUE	88	5.30	41.90	TRUE
39	5.90	42.50	TRUE	89	5.30	41.90	TRUE
40	5.50	42.10	TRUE	90	5.30	41.90	TRUE
41	5.60	42.20	TRUE	91	5.70	42.30	TRUE
42	6.20	42.80	TRUE	92	5.70	42.30	TRUE
43	6.50	43.10	TRUE	93	6.00	42.60	TRUE
44	6.70	43.30	TRUE	94	6.00	42.60	TRUE
45	6.90	43.50	TRUE	95	6.00	42.60	TRUE
46	5.60	42.20	TRUE	96	5.70	42.30	TRUE
47	5.90	42.50	TRUE	97	5.80	42.40	TRUE
48	6.00	42.60	TRUE	98	5.80	42.40	TRUE
49	5.40	42.00	TRUE	99	5.20	41.80	TRUE
50	5.70	42.30	TRUE	100	5.60	42.20	TRUE

Table 54. (Continued)

Between population size = 20 and 50							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-12.70	23.90	FALSE	51	-5.70	30.90	FALSE
2	-15.50	21.10	FALSE	52	-5.50	31.10	FALSE
3	-20.10	16.50	FALSE	53	-5.50	31.10	FALSE
4	-17.20	19.40	FALSE	54	-5.40	31.20	FALSE
5	-13.60	23.00	FALSE	55	-5.40	31.20	FALSE
6	-16.60	20.00	FALSE	56	-5.20	31.40	FALSE
7	-11.80	24.80	FALSE	57	-5.10	31.50	FALSE
8	-10.50	26.10	FALSE	58	-5.50	31.10	FALSE
9	-10.40	26.20	FALSE	59	-5.50	31.10	FALSE
10	-11.80	24.80	FALSE	60	-5.00	31.60	FALSE
11	-10.80	25.80	FALSE	61	-4.30	32.30	FALSE
12	-11.50	25.10	FALSE	62	-4.30	32.30	FALSE
13	-11.70	24.90	FALSE	63	-5.00	31.60	FALSE
14	-9.90	26.70	FALSE	64	-3.90	32.70	FALSE
15	-9.70	26.90	FALSE	65	-7.30	29.30	FALSE
16	-8.80	27.80	FALSE	66	-7.00	29.60	FALSE
17	-9.10	27.50	FALSE	67	-6.40	30.20	FALSE
18	-8.80	27.80	FALSE	68	-6.70	29.90	FALSE
19	-9.80	26.80	FALSE	69	-6.40	30.20	FALSE
20	-10.10	26.50	FALSE	70	-6.40	30.20	FALSE
21	-10.80	25.80	FALSE	71	-5.80	30.80	FALSE
22	-10.60	26.00	FALSE	72	-6.40	30.20	FALSE
23	-10.50	26.10	FALSE	73	-5.80	30.80	FALSE
24	-10.40	26.20	FALSE	74	-6.20	30.40	FALSE
25	-10.10	26.50	FALSE	75	-6.60	30.00	FALSE
26	-10.00	26.60	FALSE	76	-6.10	30.50	FALSE
27	-9.50	27.10	FALSE	77	-6.20	30.40	FALSE
28	-9.50	27.10	FALSE	78	-5.50	31.10	FALSE
29	-9.50	27.10	FALSE	79	-5.50	31.10	FALSE
30	-9.70	26.90	FALSE	80	-5.60	31.00	FALSE
31	-10.70	25.90	FALSE	81	-6.30	30.30	FALSE
32	-10.20	26.40	FALSE	82	-5.80	30.80	FALSE
33	-9.90	26.70	FALSE	83	-6.60	30.00	FALSE
34	-10.10	26.50	FALSE	84	-6.60	30.00	FALSE
35	-10.10	26.50	FALSE	85	-6.20	30.40	FALSE
36	-8.60	28.00	FALSE	86	-5.90	30.70	FALSE
37	-8.20	28.40	FALSE	87	-6.90	29.70	FALSE
38	-8.30	28.30	FALSE	88	-7.00	29.60	FALSE
39	-8.30	28.30	FALSE	89	-7.00	29.60	FALSE
40	-7.60	29.00	FALSE	90	-7.00	29.60	FALSE
41	-7.30	29.30	FALSE	91	-8.10	28.50	FALSE
42	-8.70	27.90	FALSE	92	-7.50	29.10	FALSE
43	-8.00	28.60	FALSE	93	-7.80	28.80	FALSE
44	-7.50	29.10	FALSE	94	-7.30	29.30	FALSE
45	-6.30	30.30	FALSE	95	-7.40	29.20	FALSE
46	-5.90	30.70	FALSE	96	-7.30	29.30	FALSE
47	-5.10	31.50	FALSE	97	-6.60	30.00	FALSE
48	-4.20	32.40	FALSE	98	-6.60	30.00	FALSE
49	-4.30	32.30	FALSE	99	-6.10	30.50	FALSE
50	-5.70	30.90	FALSE	100	-5.60	31.00	FALSE

Table 54. (Continued)

Between population size = 20 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-6.10	30.50	FALSE	51	5.30	41.90	TRUE
2	-4.80	31.80	FALSE	52	5.20	41.80	TRUE
3	-5.70	30.90	FALSE	53	5.20	41.80	TRUE
4	-3.20	33.40	FALSE	54	5.40	42.00	TRUE
5	-2.50	34.10	FALSE	55	5.40	42.00	TRUE
6	-3.40	33.20	FALSE	56	5.60	42.20	TRUE
7	-1.30	35.30	FALSE	57	6.00	42.60	TRUE
8	-0.90	35.70	FALSE	58	6.40	43.00	TRUE
9	-1.50	35.10	FALSE	59	6.00	42.60	TRUE
10	-1.00	35.60	FALSE	60	6.40	43.00	TRUE
11	0.50	37.10	TRUE	61	6.70	43.30	TRUE
12	0.80	37.40	TRUE	62	6.70	43.30	TRUE
13	0.60	37.20	TRUE	63	6.10	42.70	TRUE
14	1.40	38.00	TRUE	64	6.40	43.00	TRUE
15	4.40	41.00	TRUE	65	3.90	40.50	TRUE
16	5.20	41.80	TRUE	66	4.40	41.00	TRUE
17	4.70	41.30	TRUE	67	5.10	41.70	TRUE
18	3.80	40.40	TRUE	68	4.90	41.50	TRUE
19	5.10	41.70	TRUE	69	5.50	42.10	TRUE
20	5.40	42.00	TRUE	70	5.60	42.20	TRUE
21	5.00	41.60	TRUE	71	5.70	42.30	TRUE
22	5.40	42.00	TRUE	72	5.40	42.00	TRUE
23	5.50	42.10	TRUE	73	5.30	41.90	TRUE
24	5.70	42.30	TRUE	74	4.90	41.50	TRUE
25	5.80	42.40	TRUE	75	4.50	41.10	TRUE
26	6.00	42.60	TRUE	76	4.70	41.30	TRUE
27	6.10	42.70	TRUE	77	4.80	41.40	TRUE
28	6.10	42.70	TRUE	78	4.60	41.20	TRUE
29	6.10	42.70	TRUE	79	4.60	41.20	TRUE
30	6.00	42.60	TRUE	80	4.80	41.40	TRUE
31	5.40	42.00	TRUE	81	5.50	42.10	TRUE
32	5.50	42.10	TRUE	82	5.70	42.30	TRUE
33	6.20	42.80	TRUE	83	5.00	41.60	TRUE
34	6.60	43.20	TRUE	84	5.00	41.60	TRUE
35	6.60	43.20	TRUE	85	5.60	42.20	TRUE
36	7.20	43.80	TRUE	86	5.70	42.30	TRUE
37	7.30	43.90	TRUE	87	5.00	41.60	TRUE
38	7.20	43.80	TRUE	88	4.20	40.80	TRUE
39	7.20	43.80	TRUE	89	4.20	40.80	TRUE
40	7.40	44.00	TRUE	90	4.20	40.80	TRUE
41	7.30	43.90	TRUE	91	3.40	40.00	TRUE
42	6.40	43.00	TRUE	92	3.70	40.30	TRUE
43	6.60	43.20	TRUE	93	3.60	40.20	TRUE
44	6.70	43.30	TRUE	94	3.70	40.30	TRUE
45	6.70	43.30	TRUE	95	3.40	40.00	TRUE
46	6.80	43.40	TRUE	96	3.60	40.20	TRUE
47	6.80	43.40	TRUE	97	3.90	40.50	TRUE
48	6.80	43.40	TRUE	98	3.90	40.50	TRUE
49	7.00	43.60	TRUE	99	4.10	40.70	TRUE
50	5.30	41.90	TRUE	100	4.20	40.80	TRUE

Table 54. (Continued)

Between population size = 50 and 100							
Gen.	LB	UB	Significant	Gen.	LB	UB	Significant
1	-11.70	24.90	FALSE	51	-7.30	29.30	FALSE
2	-7.60	29.00	FALSE	52	-7.60	29.00	FALSE
3	-3.90	32.70	FALSE	53	-7.60	29.00	FALSE
4	-4.30	32.30	FALSE	54	-7.50	29.10	FALSE
5	-7.20	29.40	FALSE	55	-7.50	29.10	FALSE
6	-5.10	31.50	FALSE	56	-7.50	29.10	FALSE
7	-7.80	28.80	FALSE	57	-7.20	29.40	FALSE
8	-8.70	27.90	FALSE	58	-6.40	30.20	FALSE
9	-9.40	27.20	FALSE	59	-6.80	29.80	FALSE
10	-7.50	29.10	FALSE	60	-6.90	29.70	FALSE
11	-7.00	29.60	FALSE	61	-7.30	29.30	FALSE
12	-6.00	30.60	FALSE	62	-7.30	29.30	FALSE
13	-6.00	30.60	FALSE	63	-7.20	29.40	FALSE
14	-7.00	29.60	FALSE	64	-8.00	28.60	FALSE
15	-4.20	32.40	FALSE	65	-7.10	29.50	FALSE
16	-4.30	32.30	FALSE	66	-6.90	29.70	FALSE
17	-4.50	32.10	FALSE	67	-6.80	29.80	FALSE
18	-5.70	30.90	FALSE	68	-6.70	29.90	FALSE
19	-3.40	33.20	FALSE	69	-6.40	30.20	FALSE
20	-2.80	33.80	FALSE	70	-6.30	30.30	FALSE
21	-2.50	34.10	FALSE	71	-6.80	29.80	FALSE
22	-2.30	34.30	FALSE	72	-6.50	30.10	FALSE
23	-2.30	34.30	FALSE	73	-7.20	29.40	FALSE
24	-2.20	34.40	FALSE	74	-7.20	29.40	FALSE
25	-2.40	34.20	FALSE	75	-7.20	29.40	FALSE
26	-2.30	34.30	FALSE	76	-7.50	29.10	FALSE
27	-2.70	33.90	FALSE	77	-7.30	29.30	FALSE
28	-2.70	33.90	FALSE	78	-8.20	28.40	FALSE
29	-2.70	33.90	FALSE	79	-8.20	28.40	FALSE
30	-2.60	34.00	FALSE	80	-7.90	28.70	FALSE
31	-2.20	34.40	FALSE	81	-6.50	30.10	FALSE
32	-2.60	34.00	FALSE	82	-6.80	29.80	FALSE
33	-2.20	34.40	FALSE	83	-6.70	29.90	FALSE
34	-1.60	35.00	FALSE	84	-6.70	29.90	FALSE
35	-1.60	35.00	FALSE	85	-6.50	30.10	FALSE
36	-2.50	34.10	FALSE	86	-6.70	29.90	FALSE
37	-2.80	33.80	FALSE	87	-6.40	30.20	FALSE
38	-2.80	33.80	FALSE	88	-7.10	29.50	FALSE
39	-2.80	33.80	FALSE	89	-7.10	29.50	FALSE
40	-3.30	33.30	FALSE	90	-7.10	29.50	FALSE
41	-3.70	32.90	FALSE	91	-6.80	29.80	FALSE
42	-3.20	33.40	FALSE	92	-7.10	29.50	FALSE
43	-3.70	32.90	FALSE	93	-6.90	29.70	FALSE
44	-4.10	32.50	FALSE	94	-7.30	29.30	FALSE
45	-5.30	31.30	FALSE	95	-7.50	29.10	FALSE
46	-5.60	31.00	FALSE	96	-7.40	29.20	FALSE
47	-6.40	30.20	FALSE	97	-7.80	28.80	FALSE
48	-7.30	29.30	FALSE	98	-7.80	28.80	FALSE
49	-7.00	29.60	FALSE	99	-8.10	28.50	FALSE
50	-7.30	29.30	FALSE	100	-8.50	28.10	FALSE

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